REPORT ON

INVESTIGATION OF BACK-PUMPING REVERSAL AND ALTERNATIVE WATER RETENTION SITES

MIAMI CANAL AND NORTH NEW RIVER CANAL BASINS EVERGLADES AGRICULTURAL AREA

Prepared by

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for

THE SPECIAL PROJECT FOR THE PREVENTION OF EUTROPHICATION OF LAKE OKEECHOBEE

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ABSTRACT

The objective of this investigation was to develop a plan for: (a) removing from Lake Okeechobee the maximum feasible amount of water currently being discharged to the Lake at Pumping Stations 2 and 3 from the Miami and North New River Canal basins, and (b) retaining in or near the Everglades Agricultural Area the maximum feasible amount of water so removed for subsequent re-use to meet the irrigation water needs of the Miami and North New River Canal basins. Plan development involved determination of the requirements for directing runoff flow away from Lake Okeechobee and for runoff water retention/irrigation water recycling. The charge under which this investigation was made directed that the requirements for the retention/recycling portion of the plan be developed in a manner as amenable to fish and wildlife management considerations as possible.

The Holey Land Tract and the Rotenberger Tract were investigated in detail as potential retention area sites. Topographic surveys of both sites were made and seepage tests were conducted on the Holey Land Tract. Several configurations for the water retention and recycling areas were selected.

Historical records of runoff volumes discharged at Pumping Stations 2, 3, 7 and 8 were compiled. Irrigation water demands of the study area were estimated. A design for the enlargement of the Miami and North New River Canals necessary to permit runoff flow to be directed away from Lake Okeechobee was selected and tested. An array of maximum water depths for the retention areas was chosen for testing. These ranged from 1.5 ft. to 2.0 ft. for the Rotenberger area and from 2.0 ft. to 5.0 ft. for the Holey Land area. Several water level regulation schedules within these maximum depth limits were established.

Using the data obtained from the topographic surveys, on-site seepage tests, historical pumping information, historical rainfall and evaporation records, estimated irrigation demands, and the selected canal design for the Miami and North New River canals, a computer program was developed. Flow routings were performed to test the performance of the various regulation schedules and to determine the size of required intake and discharge facilities for the several retention area configurations.

The location, size, and dimensions of the facilities required to create the alternative retention areas operated at the several maximum water depths considered were determined. First costs for these facilities were calculated. Annual costs, consisting of amortized first costs and costs of operation and maintenance, were computed. The volumes of water which could be recycled for irrigation supply under various combinations of schedules and retention area configurations were derived from the routings. These volumes were related to first costs and annual costs, and cost-effectiveness in terms of recycling capability was determined.

Alternate regulation schedules and alternate retention area configurations in several combinations were evaluated. Evaluation factors used were: irrigation water recycling performance, cost-effectiveness in terms of recycling capability, total first costs, impacts on several key environmental components of Everglades ecology, effect on the Lake Okeechobee water balance, and multipurpose use of the retention area.

As a result of this investigation it is recommended that:

1. The Holey Land Reservoir (excluding the "toe" area), as described in this report, be constructed.
2. The recommended reservoir be operated under a water level regulation schedule having a 12.0 ft. to 15.0 ft. range.
3. Approximately six miles of fish concentration canals be provided as part of the initial construction of the reservoir facilities.
4. State-owned lands, either in the "toe" area or elsewhere in the State, be exchanged for the approximate 1500 acres of privately owned lands in the Rotenberger Tract east of the Miami Canal required for the recommended reservoir.
5. The Miami and North New River Canals be enlarged to the capacities recommended by the Corps of Engineers in the authorized "Water Resources Plan"; i.e., 2000 cfs and 1600 cfs respectively.
6. The enlargement of the Miami and North New River Canals be given high priority for construction under the Central and Southern Florida Project.

The plan recommended above will have an estimated first cost of $7,195,000 for the Miami Canal and North New River Canal enlargement, and an estimated first cost of $7,302,000 for the remainder of the recommended facilities. Annual costs assignable to this plan are estimated to be $620,000.

The recommended plan will direct away from the Lake an average annual volume of 203,910 acre feet of runoff water generated in the Miami Canal and North New River Canal basins which is now pumped to the Lake at Pumping Stations 2 and 3. This represents an average annual reduction of 94%.

The recommended plan will also be capable of recycling into the Miami Canal and North New River Canal service areas an average annual volume of 84,700 acre feet of irrigation water. This represents 47% of the estimated average annual irrigation water requirement of these basins. The resultant average annual increased demand on Lake Okeechobee storage will be 94,800 acre feet.

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OBJECTIVES AND PURPOSE

A management objective of the Special Project with respect to the Everglades Agricultural area is to eliminate, or substantially reduce, the annual volume of runoff water entering Lake Okeechobee from the agricultural mucklands south of the Lake. A subsidiary objective is to retain as much of the water so removed from storage in the Lake in an alternative storage area(s), in or near the Everglades Agricultural Area, for recycling into the agricultural area for irrigation purposes; water level management in such alternative storage area(s) to be compatible insofar as possible with fish, wildlife and other environmental considerations.

These objectives have been incorporated in the language of the Special Project's management recommendations for the Everglades Agricultural Area, as follows:

> "From the standpoint of water quality, it is recommended by the agencies cooperating in the Special Project that backpumping should be stopped and efforts made to reduce the quantity of water backpumped at the earliest possible date as feasibility is determined. The determination of feasibility is dependent upon water quantity considerations, engineering, and social/economic costs as well as water quality.
>
> "It is recommended that runoff water from the Everglades Agricultural Area be stored in or near the Everglades Agricultural Area for subsequent re-use as irrigation water."

The purpose of the present study is to develop a management plan meeting the above objectives for the North New River and Miami Canal basins of the Everglades Agricultural Area. The Special Project's charge with respect to this study is given, in part, below:

> "The determination of regulation schedules and maximum pool depth is basic for evaluation of the amount of water that can be stored in various available areas. The Central and Southern Florida Flood Control District, working with the Florida Game and Fish Commission with appropriate consultation with the Division of State Planning and Department of Environmental Regulation will determine a maximum water level depth and regulation schedule, as soon as feasible. From that point, evaluations of the various areas available for storage will be made and a detailed plan developed to store as much as possible of the 350,000 acre feet of irrigation water needed in the Everglades Agricultural Area annually from water formerly backpumped in a manner as amenable to fish and wildlife management considerations as is possible.
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> "The plan for the Miami Canal and North New River Canal basins, which will involve evaluation of (1) the Holey Land Tract, (2) the Rotenberger Tract, (3) the northern portion of Conservation Area 3, and (4) combinations of the above, will be delivered to the Lt. Governor for approval no later than January 1, 1976."

DESCRIPTIVE INFORMATION

Study Area Location

The study area of this report is shown on the map of Figure 1. Delineated on this map are the limits of the Everglades Agricultural Area, the boundaries of the areas served, respectively, by Pumping Station 2 (S-2) and Pumping Station 3 (S-3), and the limits of that portion of the S-2 service area which drains to the North New River Canal. Also shown are the boundaries of that tract of State-owned lands known as the Holey Land, the so-called Rotenberger Tract, and the lands within the Agricultural Area owned by the Seminole Tribe of Florida. Other pertinent features of the study area are indicated on the map.

The C&SF Project System

Under the Central and Southern Florida Flood Control Project, authorized in 1948 by the Congress, the Everglades Agricultural Area was encircled by protective levees, designated Levees 4, 5, 6 and 7. The four old Everglades Drainage District canals traversing the Agricultural Area were enlarged and diked on both sides. The Miami and North New River Canals, involved in this study, are two of the four canals so enlarged. Canal enlargement was such as to permit removal of surplus runoff from the adjacent lands at a peak rate of 3/4" per day, providing protection from flooding as a result of a storm event having a five-year frequency of occurrence.

The Project system is designed so that runoff entering the northerly reaches of the Miami, North New River and Hillsboro Canals is discharged to

Lake Okeechobee. Runoff reaching the southerly reaches of these three canals and all of the West Palm Beach Canal is discharged southward to the water conservation areas. The Lake portion of Miami Canal runoff is handled at S-3; the Conservation Area portion at Pumping Station 8 (S-8). The Lake portion of the North New River Canal runoff is handled at S-2; the Conservation Area portion at Pumping Station 7 (S-7). The Lake pumping station S-2 also handles runoff from the northerly reach of the Hillsboro Canal; that canal and the North New River Canal joining to form a single channel before entering the Lake in the vicinity of Belle Glade.

The design discharge capacity of each of the four pumping stations involved in this study are listed below:

Pumping Station	Discharge Capacity (cfs)
S-2	3,600
S-3	2,580
S-7	2,490
S-8	4,170

The size of the pertinent drainage service areas are listed below:

Pumping Station	Canal	Service Area (sq.mi.)
S-2	Hillsboro Portion	56
S-2	North New River Portion	110
S-3	Miami	100
S-7	North New River	125
S-8	Miami	200

Average annual discharge, and average wet season discharge (June-October), for the period 1962-1973, for each of the above service areas is listed below:

Service Area		Average Annual Discharge, A.F.	Average Wet Season Discharge, A.F.
S-2, Hillsboro		100,427	65,330
S-2, North New River		118,750	84,730
S-3, Miami		97,920	69,320
Sub-total, discharge to Lake Okeechobee	-	317,097	219,380
S-7, North New River		116,100	78,800
S-8, Miami		98,610	81,390
Sub-total, discharge to Conservation Areas	-	214,710	160,190

The service areas which are pertinent to this study are those listed in the previous tables with the exception of the Hillsboro Canal area.

Figures 2 and 3 show the channel bottom elevation, adjacent natural ground surface elevation, and design water surface profile for the North New River and Miami Canals respectively. Because of the system design which calls for northward water flow in the northern reaches of both these canals and southward flow in the remainder there is a long middle reach in which the canal bottom is higher than at either end. These elevated reaches are the so-called "humps" in these canals. There is a corresponding raise in the design water surface elevation; the water surface gradient under discharge conditions being created by pumping at both the north and south ends of these canals.

Pumping Station 7 discharges into Conservation Area No. 2A. There is also the capability to discharge North New River Canal runoff by gravity into Conservation Area No. 3A by way of Structure 150.

Pumping Station 8 discharges into Conservation Area No. 3A. Discharge at S-8 enters Canal 123, a channel located west of the old Miami Canal across the northern portion of Conservation Area No. 3A. Canal 123 was constructed in order to improve the capability for conveying water across the conservation area marsh to meet the requirements, when needed, for supplemental water to Everglades National Park and the lower east coast by transferring water from Lake Okeechobee. C-123 was completed in 1972.

The capability exists at both S-7 and S-8 to discharge by gravity when head conditions are favorable.

Land Use and Irrigation Supply

Irrigation water is introduced into the North New River and Miami Canals to meet supplemental water requirements in those service areas by making releases from the Lake at HGS#4 (S-2) and HGS#3 (S-3) respectively. During the irrigation season (November-May) an optimum irrigation stage between 12.0 and 12.5 ft.msl. is maintained in the North New River and Miami Canals. Releases are made from the Lake in quantities sufficient to maintain those stages. When Lake level recedes below the optimum irrigation stage, the North New River and Miami Canals take the same stage as the Lake. Irrigators withdraw supplemental water directly from the North New River and Miami Canals.

Land use in the service areas pertinent to this study is shown on the map of Figure 4. Estimated acreage in agricultural production (1974) by service area is shown in the following table:

Service Area	Sugar Cane	Pasture	Truck	Total Ag.Use	Percentage of Service Area	Other
S-2, NNR	27,320	27,360	4,840	59,520	86%	9,600
S-3, Miami	45,020	21,520	20	66,560	81%	16,000
S-7, NNR	36,960	34,240	1,280	72,480	91%	7,520
S-8, Miami	42,270	7,680	-	49,950	38%	83,170
Total -	151,570	90,800	6,140	248,510	68%	116,290

Estimated average annual supplemental water requirement based on the land use from 1963-1973 is 115,000 A.F. for the North New River Canal basin and 64,500 A.F. for the Miami Canal basin. For all practical purposes, all of the lands in production are irrigated during the period November 1 - May 31.

The Holey Land

The boundaries of the Holey Land are depicted on the map of Figure 1. The entire area is State owned, under the jurisdiction of the TIITF. The area is presently under lease to the State Game and Fresh Water Fish Commission for wildlife management purposes. Natural ground elevations along the north and south boundaries of this tract, based on surveys conducted by the Flood Control District in September-October, 1975, are plotted on Figure 6.

This tract is bounded on the south by Levee 5 which consists of a low interior levee (on the Holey Land side), an exterior levee (on the Conservation Area side), and a borrow canal between the two levees. A major FP&L transmission line is located immediately north of, and adjacent to, the L-5 interior levee.

The Rotenberger Tract

The boundaries of the Rotenberger Tract are depicted on the map of Figure 1. On this map are indicated those parcels of land within the Tract which are in private ownership. It is to be noted that a portion of the Rotenberger Tract, approximately 3,580 acres, lies east of the Miami Canal and abuts the Holey Land on the west. The Miami Canal is leveed on both sides as it traverses the Rotenberger Tract. Natural ground elevations along the north and south boundaries of this tract, based on the recent District surveys, are plotted on Figure 9. That portion of this tract lying west of the Miami Canal is separated from Conservation Area No. 3A by the one-mile wide tier of sections which is a part of the State Seminole Indian Reservation. (See Figure 1).

Northern Portion of Conservation Area No. 3A (East of C-123)

The Flood Control District holds storage and flowage easements over all of Conservation Area No. 3A. The Game and Fresh Water Fish Commission, under lease from the District, manages the area for fish and wildlife. Topographic surveys of the northerly portion of Conservation Area No. 3A were not conducted in connection with this investigation. It can be reasonably assumed that natural ground elevations along the northern boundary of the conservation area, east from the Miami Canal, closely approximate the ground elevations along the south boundary of the Holey Land. Ground slope may be on the order of 0.30 ft. per mile toward the south.

PROBLEM STATEMENTS

Flow Re-direction

In order to eliminate or substantially reduce the amount of poor quality water entering the Lake from the Miami Canal and North New River Canal basins it is obviously necessary to re-direct to the south the present northerly flow of discharge in the northern reaches of those canals. To accomplish this the existing restricted sections, or "humps", in those two canals must be removed.

The extent of required "hump removal" is conditioned by several considerations, as follows:

a. The amount of flow which is to be re-directed.

b. The capability of Pumping Stations 7 and 8 to accept both the re-directed flow from the northerly portions of the canal basins and the flow they now receive from the southerly portions; and

c. The maintenance of reasonable and acceptable flood discharge water surface elevations in the northern reaches of both canals consistent with C&SF Project authorizations and obligations.

Because of the fact that S-2 now accepts runoff flow from both the North New River Canal and Hillsboro Canal basins it will be necessary to separate those flows. Hillsboro Canal flows will still continue northward to S-2, whereas flows generated in the northern portion of the North New River Canal are to be re-directed southward. Under this flow regime, design flow stages in the Hillsboro Canal near S-2 would be on the order of 8.0 ft.msl. while design flow stages in the North New River Canal near S-2 would be on the order of 13.0 ft. msl. Structural measures are required to ensure that this stage differential will result.

The problem statements under this heading, therefore, are:

1. Determine the required "hump removal" channel design for the North New River and Miami Canals.

2. Evaluate the performance of the "hump removal" channel design in terms of the quantity of flow which can be re-directed from the Lake.

3. Determine the hydraulic requirements, and select a tentative location, for the flow regulation structure in the North New River Canal.

Retention Area

Flow re-direction alone would accomplish the objective of eliminating or substantially reducing the inflow from the North New River Canal and Miami Canal basins to Lake Okeechobee. However, the subsidiary water quantity management objective requires the establishment of a retention area to act as an alternative water storage facility for some portion of the water to be removed from storage in the Lake.

In addition to this consideration, there is the fact that without provision of an "upstream" retention area all of the re-directed flow would enter Conservation Areas 2A and 3A. In Conservation Area 2A the increased quantity of inflow water, of poor quality, could have an adverse impact on the environment there; an environment which has already experienced some changes as a result of existing inflows.

Re-directed flows at S-8 would, for the most part, be routed downstream in C-123 and thus be of no benefit to the environment in that portion of the conservation area north of Alligator Alley. A suitably located upstream retention area should consequently permit a better distribution of the re-directed flow over the northerly portion of Conservation Area No. 3A east of C-123.

These two considerations add emphasis to the desirability of an upstream alternative runoff water retention site within the Everglades Agricultural Area.

The environmental values of alternative retention areas, either existing or potentially restorable, must also be considered together with other uses which would be compatible with the basic objective of recycling of water and the corollary goal of obtaining a more acceptable distribution of flow over the northern portion of Conservation Area No.3A. Basic to all of these considerations is the water level management schedule for the alternative retention area(s).

Of primary importance is the matter of the water balance within the retention area(s) itself. This involves such considerations as:

a. Amount of inflow water available for filling the retention area.

b. Net amount of direct rainfall to be stored in the area(s).

c. Evapotranspiration loss.

d. Seepage rates and losses.

e. Water level management schedule.

Consequently, the problem statements for this aspect of the study are:

4. Determine the location and areal configuration of the retention area or areas.

5. Determine the water level management schedule for the retention area or areas.

6. Evaluate the performance of the retention area(s) with respect to filling capability and water recycling capability under various water level management schedules.

7. Project the on-site environmental consequences under various water level regimes.

8. Identify other possible uses for the retention area(s).

Overall Plan

The two essential features of the overall plan are: (a) the system for re-direction of flow in the northern reaches of the North New River and Miami Canals, and (b) the water retention/recycling system.

There are no particular or special design considerations to be taken into account with regard to the flow re-direction system once the "hump removal" requirements are established and a determination made of the hydraulic requirements of, and suitable location for, the required flow regulation structure in the North New River Canal. The elements of cost for this portion of the plan are: (a) channel excavation in the North New River and Miami Canals, and (b) flow regulation structure, including the cost of excavating a temporary by-pass channel.

From an operational standpoint it must be understood that there will be occasions when pumping at S-3 will be required. These occasions will result from storm events producing peak runoff rates in excess of the pumping capacity at S-8 and/or the channel capacity through the former "humps". A maximum design flood discharge water surface profile for the Miami Canal under the re-directed flow regime will be established. Operational guidelines should be such that all pumping in the Miami Canal will be at S-8 until the new design stage at S-3 is exceeded. Once S-3 is started up, however, stage at that location can no longer be used to determine when operation of S-3 is to cease. A suitable location in the Miami Canal at which to record stage for governing operations at S-3 must be selected and a determination of the governing stage at that location made.

Similar operational guidelines will be required for the North New River Canal system. Here, however, since S-2 will be operating to pump Hillsboro Canal inflow, operational guidelines must be related to operation of the flow regulation structure rather than the pumping station (S-2). At this location the probability exists that on many occasions it will be possible for Hillsboro Canal flow to be re-directed southward into the North New River Canal through the flow regulation structure. The operational guidelines will have to address this probability as well.

Concerning the retention area(s), filling will be accomplished by introducing therein some portion of the re-directed flow in the North New River and Miami Canals. Flow introduction must be by means of pumps. Basic considerations in regard to the sizing of the pumps are:

(a) Required rate of retention area filling.

(b) Time duration and pattern of water availability for filling.

(c) Hours of required pumping operation.

(d) Determination of necessity for recirculation of seepage outflow.

(e) Provision of "flow-through" capability for redistribution of flows to Conservation Area No. 3A.

Other considerations to be taken into account in the design of the retention area(s) storage/recycling system are:

(a) Containing levee dimensions and construction.

(b) Means of bringing inflow water to, and recycling water away from, the boundaries of the retention area.

(c) Facilities for distribution of "flow-through" outflow to Conservation Area No. 3A.

(d) Emergency discharge facilities.

(e) Location and dimensions of seepage control ditches and control structures.

(f) Nature and location of additional facilities related to other possible uses of the retention area(s).

All of the above features, obviously, represent items of capital cost. In addition, use of certain of the potential sites for the storage of water will require that privately owned lands be acquired; this acquisition also represents an initial capital outlay.

There are no special considerations involved in the operation of the retention area system. Operations during the retention area filling period (June-October) will be governed by the regulation schedule and the availability of water. During the recycling period (November-May) operations will be governed by irrigation supply requirements expressed as optimum irrigation stage in the North New River and Miami Canals, and by the regulation schedule. Specific guidelines for "flow-through" operations will be required.

Several bases exist for evaluating a program or plan of the type being investigated in this report. Among the quantifiable factors which might be considered in plan evaluation are:

(a) First costs.

(b) Annual costs.

(c) Volume of water removed from the Lake.

(d) Volume of water recycled to the Agricultural Area.

(e) Volume of water redistributed to Conservation Area No. 3A.

(f) Impact on Lake Okeechobee water budget.

Other evaluation factors which might be considered are on-site environmental benefits or damages, value of use of the retention area(s) for additional compatible purposes, increased financial and energy costs to agricultural interests, and muck subsidence. Most of these considerations, however, are not quantifiable in monetary terms. Evaluation would be largely subjective.

The problem statements for this portion of the study, therefore, are:

9. Determine the nature, location and dimensions of the retention area facilities required to provide for runoff water retention, runoff water "flow-through", irrigation water recycling, seepage control, and safety.

10. Determine the nature, location and dimensions of additional facilities needed to permit other identified compatible uses to be made of the retention area system.

11. Determine the type and dimensions of the required flow regulation structure in the North New River Canal.

12. Prepare first costs and annual costs for items 8 through 10, above, for "hump removal", and for land acquisition (where applicable).

13. Develop guidelines for the operation of S-2, S-3, S-7, S-8, and the flow regulation structure in the North New River Canal under the altered flow regime.

14. Develop operational guidelines for the retention area system.

15. Formulate an evaluation methodology and evaluate the overall plan accordingly.

STUDY APPROACH

The development of a management plan of the type being investigated herein usually resolves itself to a matter of making a selection of one solution out of several possible alternate solutions on some objective basis. This is the general approach which has been taken in this investigation.

In this case there is a comparatively large number of independent variables, and each variable has a wide range of possible values. Consequently, there is a potentially large number of alternatives which can be presented for evaluation by means of some objective function. The variables in this instance are:

a. "Hump removal" dimensions for each of two canals.

b. Number of separate retention areas.

c. Size/configuration of the retention areas.

d. Water level management schedule for the retention areas.

Even if a limited number of possible values were assigned to each variable the number of combinations, or alternatives, would still be large.

In order to reduce the analytical task to manageable proportions professional judgment and experience in several areas of expertise were exercised in making a selection of values for the several independent variables.

Accordingly, as a result of initial decisions made on the basis of professional judgment, experience and an assessment of practicability the basic analysis of this report is predicated on the following:

1. The "hump removal" channel design for the Miami and North New River Canals is that which will provide the hydraulic conveyance capability authorized for construction under the C&SF Project by the Congress in 1968. Practical considerations of funding dictated this selection since this design can be accomplished with the Federal Government underwriting 80% of the cost of construction. In addition, a preliminary performance analysis conducted in the earlier stages of the Special Project's studies indicated good results in terms of flow re-direction would be obtained with this design.

2. The retention area on the east side of the Miami Canal lying north of Levee 5, which includes the Holey Land Tract plus that portion of the Rotenberger Tract east of Miami Canal, is considered to be the primary site for water retention. The remainder of the Rotenberger Tract, lying west of the Miami Canal, is considered as a secondary site to be used, if at all, only in conjunction with the site east of the Miami Canal.

3. The basic configuration of the site east of the Miami Canal (called hereafter in this report the "Holey Land Reservoir") is considered to be the Holey Land Tract less the "toe" plus the portion of the Rotenberger Tract east of the Miami Canal. An alternative configuration includes the "toe" of the Holey Land.

4. A wide range of regulation schedules for the two Holey Land Reservoir configurations up to a maximum water depth of five feet; the maximum depth having been selected based on a combination of cost, engineering

and environmental considerations. A narrow range of regulation schedules for the "Rotenberger Reservoir" (water depths of 1.5 and 2.0 feet only); this selection based on the practical consideration that this area will be managed exclusively for deer.

The main body of this report, which is incorporated in the following sections, addresses the problem statements enumerated earlier within the framework determined by the pre-selection of certain values as identified above.

FLOW RE-DIRECTION

General

The plan presented by the Corps of Engineers in its Water Resources Report for the Central and Southern Florida Project included as one of its features the removal of the "humps" in the Miami and North New River Canals. The plan recommended by the Corps in that report was authorized by the Congress in 1968. That authorization established a construction cost-sharing ratio for all features of the plan of 80% Federal and 20% State.

The purpose of the "hump removal" as set forth in that plan, was to provide an additional means for reducing Lake Okeechobee levels when stages were above prescribed regulatory elevations. The objective is to reduce the amounts of water discharged for regulatory purposes to tidewater at the St. Lucie Canal and Caloosahatchee River outlets. By using the Miami and North New River Canals to the extent possible regulatory discharge water would be retained in, or flowed through, the Everglades system consisting of the water conservation areas and Everglades National Park.

A system designed to handle Lake Okeechobee regulatory discharges via the Miami and North New River Canals can also be used to re-direct runoff flows away from Lake Okeechobee. The two water management objectives are not competitive. Use of the Agricultural Area canals for Lake regulation cannot be made while those canals are discharging local runoff. Therefore, in either case - the present system or the system being investigated in this report - removal of local runoff from the Agricultural Area is first accomplished before the canals can be used for Lake regulation.

Miami Canal

The Corps of Engineers' hump removal design calls for a Lake regulation capacity of 2000 cfs. The plan for the Miami Canal also calls for the installation of a water level control structure near the present pumping divide between

S-3 and S-8. The purpose of this structure is to permit different optimum water control elevations to be held north and south of the control based on differences in general adjacent natural ground elevations. The justification for such a structure must be re-visited; particularly in view of current construction costs. It is presently believed that justification will be marginal at best. Accordingly, this investigation assumed that the structure would not be provided under the Central and Southern Florida Project.

Standard backwater computations were performed using the Corps of Engineers' channel design sections for 2000 cfs capacity, an "n" factor of 0.30, and an assumed design drawdown stage of 9.5 ft.msl. at S-8. These computations indicated that elimination of the water level control structure at the present pumping divide results in a design discharge capacity of 2600 cfs. Channel capacity may be reduced below this value dependent on rainfall distribution in the basin. The resultant channel design and design water surface profile is shown on Figure 2. The design water surface profile for flow re-direction is comparable to that established by the Corps of Engineers for Lake regulation discharge.

There will be occasions of more severe storm events when runoff entering the Miami Canal will produce flows exceeding the capacities of S-8 and the proposed retention area pump(s). Stages greater than design stage in the northern reaches of Miami Canal will then result. Operational criteria, therefore, shall be such as to require S-3 to be placed into operation when stage at the land side of S-3 reaches design stage of 13.3 ft.msl. The determination of when to stop pumping at S-3 will be made by a combination of "trial and error," stopping pumping at intervals and observing stage response, and by observing changes in pumping rates at both S-3 and S-8.

Daily routings over the 1962-73 historical period performed as a part of this investigation indicated that there were only 16 days during which pumping at S-3 would have been required. The average wet season volume pumped at S-3, under this flow regime, is 1560 A.F., as compared with the present average wet season volume of 69,320, a 98% reduction in back-pumped discharge to Lake Okeechobee.

North New River Canal

The Corps of Engineers Lake regulation "hump removal" design calls for a capacity of 1600 cfs. Here, again, the Corps' plan calls for a water level control structure at the present S-2, S-7 pumping divide for the same purposes as in the Miami Canal. The present investigation assumed this structure also to be removed from its location at the pumping divide. In this case, however, a structure of similar design and capacity is required near the confluence of the North New River and Hillsboro Canals in order that S-2 can continue to pump runoff from the northern reach of the Hillsboro Canal. The required capacity of this structure is 1600 cfs., since that capacity is governed by the Lake regulatory discharge requirement. The design head loss at the structure to pass 1600 cfs. is 0.4 foot.

Standard backwater computations were performed, as with the Miami Canal, using an "n" factor of 0.30 and a design drawdown stage of 9.5 ft. msl. at S-7. Elimination of the water level control structure at the present pumping divide produces a design discharge capacity of 2200 cfs. Channel capacity may be reduced below this value dependent on rainfall distribution in the basin. The resultant channel design and design water surface profile are shown on Figure 3. As with the Miami Canal, the design water surface profile is comparable with the profile established by the Corps for Lake regulatory discharge.

Daily routings over the historical period showed that there were 102 days on which S-2 would have been required to pump North New River Canal runoff. The average wet season discharge from the North New River Canal basin at S-2 is 11,200 A.F. as compared with the present average wet season discharge of 84,730 A.F., an 87% reduction.

The historical average wet season total discharge (including the Hillsboro Canal) at S-2 is 150,060 A.F. The flow re-direction plan discussed herein will reduce that discharge to 76,530 A.F., a reduction of 49%.

This reduction represents a minimum estimate since there will be yearly a number of occasions of comparatively minor runoff producing events when discharges from the Hillsboro Canal can be diverted through the proposed flow regulation structure into the North New River Canal without exceeding critical stages in the northern reach of Hillsboro Canal.

The flow regulation structure can be operated in three modes: (1) closed to completely separate North New River Canal and Hillsboro Canal flows, (2) open to divert Hillsboro Canal flows to S-7, and (3) open to pump North New River Canal flows to S-2, as at present.

Operation under mode (3) will be governed by stage at the S-7 side of the structure; when stage reaches 13.3 ft. msl. on the S-7 side the structure will be opened sufficiently to maintain a 13.3 ft. stage. Operation under mode (2) will be governed by stages in the Hillsboro Canal; the structure will remain open as long as stages in the northern portion of the Hillsboro Canal remain below critical stages, S-6 is not over-loaded, and there is a southward water level gradient toward S-7 past the structure.

Summary

Based on the 1962-73 historical record the selected "hump removal" design will reduce the average wet season total discharge at S-2 and S-3 from 219,380 A.F. to 78,090 A.F.; a reduction of 141,290 A.F., or 64%, in back-pumping to Lake Okeechobee. This is a conservative figure, but provides a reasonable basis for evaluation of performance of the selected design. Annual discharge to the Lake from the study area will be reduced from 216,670 A.F. to 12,760 A.F.; a reduction of 94%.

RETENTION AREAS

Retention Area Size

The Holey Land Reservoir site, without the "toe" (basic configuration), comprises a total of 31,550 acres; 27,970 acres of which are in the Holey Land tract and the remainder in the Rotenberger tract east of the Miami Canal (Figure 5). An average ground elevation of 12.0 ft.msl. was used for storage calculations, based on District survey.

The "toe" contains 3,800 acres, giving a total area of 35,350 acres for this alternative retention site.

The Rotenberger Reservoir site comprises 19,110 acres (Figure 8). An average ground elevation of 12.5 ft. msl. was used for storage calculations, based on District surveys.

Basic Hydrological Data

Daily rainfall of pump station S-8 was used to represent the rainfall over the proposed retention areas. A summary of monthly totals is given in Table 1. Forty-five years of rainfall record at the Belle Glade Experiment Station, 17 miles north of the area, indicate that the period of record considered (1963-1975) was quite representative of long term trends. The mean yearly rainfall at this station was 57.70 inches when the entire 45 year record was considered and 56.09 inches when only the 13 year study period was used.

A summary of monthly sums of runoff and irrigation demand is presented in Tables 3 and 4.

Evapotranspiration in the retention areas was considered to be approximated closely by the pan evaporation as measured at Pumping Station S-7. In order to facilitate data handling, the measured monthly pan evaporation was divided by the number of days in that month to obtain a representative daily evapotranspiration. Monthly pan evaporation is tabulated in Table 2.

Daily seepage was estimated by Darcey's Equation, $Q = kli$, where Q = seepage, k = weighted transmissibility of the shallow soil profile, l = length of the levee, and i = hydraulic gradient. The transmissibility values were determined by the Flood Control District from an on-site testing program in the Holey Land and supplemental data published by the Corps of Engineers. Seepage values varied from 50 to 300 acre ft. per day for the Holey Land area depending on pool stage. The report of the on-site seepage investigations conducted by the District are attached as Appendix 1 to this report.

Irrigation demand was estimated as the total loss from the respective canal systems on days in which there was no net runoff from these canals. In actual operation, releases for "irrigation" will be governed by the stage in the project canal system falling to a key elevation. Since historical irrigation releases have been made on similar criteria, it is expected that the irrigation demand calculated in this manner will provide an adequate approximation of future conditions.

Total runoff generated within the Miami Canal and North New River Canal drainage areas was computed as the sum of daily outflows generated within the area. This was accomplished by adding the positive daily differences between inflows and outflows. In the Miami Canal area this is equivalent to the total S-8 discharge minus the total discharge at the S-3 - HGS3 complex. In the North New River Canal area it is total S-7 and S-150 discharges minus the discharge at the North New River Canal station below HGS4. The sign convention used on all discharge stations was, that flow southward, away from Lake Okeechobee, be considered positive. Thus, when runoff was pumped into Lake Okeechobee from S-3 or S-2 the sign of this discharge was negative. Similarly when discharges were made southward from S-7 or S-8 the discharge from these stations would be positive. If runoff was occurring at the same time on each end of the canal, subtracting a negative number from a positive number resulted in a combined positive number larger than the absolute value of either station and equal to the total runoff generated between these stations. The summations of the negative values of these differences were considered as irrigation demands.

The runoff values for the North New River Canal area are not exactly true representations of runoff because of the unique interconnection between this area and the Hillsboro Canal area. For the purposes of routing flow into and past the proposed retention area(s), however, the runoff values can be considered adequate as the indicated runoff in excess of the true runoff may be considered that part of the runoff generated in the Hillsboro Canal area which could not be handled by S-6. This same interconnection will also affect the irrigation demand for the North New River Canal area in that it will tend to over-predict irrigation demand. No attempt was made to correct for this tendency and should be considered in analyzing the results.

Regulation Schedules Considered

A wide range of representative regulation schedules for the Holey Land Reservoir were selected for performance evaluation. These schedules in feet mean sea level were 12-17, 12-16, 12-15, 12-14, 13-17 and 13-16. The schedules in the Rotenberger Reservoir were 12.5-14.0 and 12.5-14.5. Ground level was assumed as 12 ft. msl. in the Holey Land Reservoir and 12.5 ft. msl. in the Rotenberger Reservoir.

Several of these alternatives were selected primarily for evaluation of possible vegetation, fish, wildlife, and on-site water quality factors. Among these were the schedules for the Rotenberger Area and the 13.0 ft. msl. base regulation for fishery benefits. The 12.0 ft. regulation schedules were selected basically for their compatibility with wet prairie development. (See pages 31 to 48 for detailed discussion of these considerations.)

The maximum stage of 17.0 ft. msl. was selected as representing the highest practicable regulation stage, based on cost considerations related to predicted environmental changes. It is clear that water depths in excess of 5 feet will create an open-water environment, thus increasing the hazard of levee overtopping during hurricane storm events. This would require, at least, increasing levee freeboard requirements, substantially increasing construction costs.

Routing Procedure

A routing procedure was developed for the proposed retention areas to determine:

1. The effect of changing the size of the holding areas.
2. Testing the sizing of tentative intake and outflow control structures.
3. Testing the effect of selected regulation schedules.
4. Evaluating the performance of the holding area(s) with respect to filling capability and water recycling capability.

The routing was performed on a daily basis by the simple addition or subtraction of direct rainfall on the retention area(s), evapotranspiration, seepage, irrigation withdrawals, outflow through the spillways, and inflow pumped from the North New River and Miami Canals. The variables which were dependent on stage in the retention areas, e.g., seepage, irrigation, outflow, and inflow were calculated on the basis of the previous day's stage.

Routings used historical daily flow records for an estimate of the amount and timing of water available for filling the retention areas and also as an estimate of irrigation demand. Rainfall and evapotranspiration estimates were made for corresponding time intervals.

The routing procedure allowed the deliveries for irrigation to be equal to the irrigation demand in all days except when stages in the retention area were below a monthly (irrigation) regulation stage or demand exceeded 600 cfs in the respective canal system. Below these regulation stages all deliveries were terminated and any deficits were assumed to be made up by deliveries from

Lake Okeechobee. In all routings that allowed stages to recede to ground elevation, this regulation stage was set at 12.5 ft. msl. or approximately 0.5 feet above mean ground elevation for the entire year. At approximately this elevation flow toward the irrigation delivery structures will begin to be restricted severely by the resistance of the marsh grasses to overland flow. Thus, this criteria essentially makes all available water ready to meet irrigation demand until the supply runs out.

For regulation schedules requiring a minimum pool stage of 13.0 ft.msl. irrigation withdrawals were terminated below a stage of 14.0 to prevent excessively low stages in May.

The routing for various regulatory schedules and physical configurations were run over the entire period of record, 1963 through 1973. Thus, the system response could be evaluated with the various alternatives as though the retention areas had been constructed in 1963 and continued through 1973. Continued development of agricultural lands might be expected to increase both irrigation demands and the total amount of runoff generated on these lands for the same meteorological conditions. It is expected, however, that historical records should provide a good estimate of future conditions for the next decade or more. This is a reasonable assumption in view of the fact that, excluding the Rotenberger and Holey Land Tracts, over 80% of the area involved is already in agricultural production. (See page 6).

Spillway outflow was considered to occur in a fashion equivalent to the flow over a weir. The elevation of the weir being set by a (spillway) monthly regulation schedule. At elevations above these regulation elevations spillway discharges occur. Special provisions were included to override the regulation schedule and lower the equivalent weir elevation when stages became excessively higher than the regulation levels. Because the envisioned operational criteria called for very shallow water depths at certain times of the year, the possibility that resistance to overland flow would become the limiting criteria in how much water could be removed rather than structure characteristics became evident. In order to provide a first approximation of this effect the flow predicted by structure control was multiplied by the flow depth cubed when the flow depth was less than 0.75 ft. This procedure is in general agreement with the development of Izzard's overland flow equation which predicts that the velocity of overland flow varies with the cube of the flow depth.

Inflow from the North New River and the Miami Canals which was pumped to the Holey Land Reservoir was constrained primarily by (1) the availability of storage below the (inflow) regulation schedule, (2) the pump capacities and (3) the availability of runoff generated within the basin. The routing procedure assumes that pumping was only allowed when there was positive runoff generated within the respective canals and the stage within the retention area was below the monthly stage specified in the (inflow) regulation schedule. If both these criteria were met, the lower of either the pump capacity or the runoff in the respective canals was chosen as the inflow. An additional constraint was imposed that the maximum rise in stage during June was not to exceed one foot. This constraint was imposed based on environmental considerations in order to protect emerging vegetation during the germination and seedling stage.

Pumping was prohibited during periods in which runoff was not being generated within the basin because it is obvious that water should not be taken from the more efficient storage in Lake Okeechobee to replenish a deficiency in the less efficient alternative retention.

The same type of constraints in regard to spillway outflow that were applied in the Holey Land Reservoir(s) were also applied to the Rotenberger Reservoir.

The inflow to the Rotenberger Reservoir was not allowed to exceed the difference between the runoff generated in the Miami Canal drainage area and the inflow to the Holey Land Reservoir(s) from the Miami Canal. This condition was applied to ensure that the maximum possible amount of runoff stored would later be made available for reuse as irrigation water and thereby reduce to some extent the draw on Lake Okeechobee toward the end of the dry season.

Routing Results

All of the regulation schedules identified earlier herein were tested with the routing program. Outflow for purposes other than irrigation was allowed only when the computed pool stage was above a set monthly elevation. This stage varied from the minimum regulatory stage in May to the maximum regulatory stage the end of September through January (or in the case of the 17.0 foot maximum, through December). For the transitional periods, the regulatory stages were increased in equal monthly increments for the months of June through August and similarly decreased for the months February through April.

Pumping into the Holey Land Reservoir was allowed whenever the calculated pool stage was less than 0.2 foot above regulation stage. This was to ensure that the maximum possible amount of water would be diverted from S-7 and S-8 for more desirable distribution in Conservation Area 3A. An exception to this rule was made when the regulation stage was less than 0.5 foot above ground surface. In this case, resistance to flow provided by the natural vegetation becomes large enough to severely restrict direct flow through the area.

The allowable monthly rise in stage has a definite effect on the maximum pool stages that can be obtained. Restricting maximum stages during the first part of the rainy season (June through October) requires that some of the wet season rainfall be released as excess early in the rainy season. In years where the majority of rainfall occurs in June or July, there may not be sufficient rainfall in August through October to raise stages above 16.0 or 17.0 feet msl.

The shape of the descending portion of the regulation schedule has little effect on stages in this retention area particularly in drier than normal years. The demands on the retention area for supplemental water are quite high resulting in a rapid decline in pool stage beginning in October or November during most years. As this natural decline is faster than would normally be envisioned for a regulation schedule, this portion of the regulation schedule has little effect on subsequent or interim stages.

Releases from the reservoir to control stages in the primary canal system (irrigation) were made with no restrictions in timing. This effectively allowed the retention area to supply nearly all of the supplemental water requirements during the early part of the irrigation season. This accounts for the rapid fall i stage at the beginning of the irrigation season. The supplemental water requirements during the later part of the irrigation season would be made up from Lake Okeechobee. This method allowed the more efficient carry-over capacity of Lake Okeechobee to be utilized for storing water rather than the smaller retention area with its higher attendant losses.

A representation of stages in the retention area(s) which might have occurred under past hydrologic conditions is given in Figures 10A, B and C. The representations are average monthly stages derived from the routing program. Stages achieved under a given regulation schedule did not vary significantly with the addition of the"toe" area to the Holey Land Reservoir. When the maximum possible water was passed through the Holey Land for distribution in Conservation Area No. 3A, stages rose as much as 0.5 foot above the stages shown during the peak stage periods

For the Holey Land Reservoir, stages of 17.0 feet msl. could be reached in 60 percent of the years; stages of 15.0 feet and 16.0 feet msl. could be reached in 90 percent of the years; and a stage of 14.0 feet msl. could have been reached in every year of record.

There is often a high demand for supplemental water in November and December which will generally tend to make stage at least 1.5 feet lower than the maximum regulatory stage by the end of December.

The variability of hydrologic inputs resulted in the pool going dry before April 1 in 2 of the 11 years between 1964 and 1974 under the 12.0 - 16.0 feet msl. regulation schedule. After going dry the pool generally began to fill around June 10. Less severe dry periods caused the pool to dry for shorter periods. In 5 of the 11 years the pool was dry for at least 20 days. In the remaining 6 years there was generally about 0.5 foot of water over the pool during lowest stages.

The 12.0 - 17.0 foot regulation schedule showed similar trends but delayed the dates when the pool went dry by approximately 5 days.

Two regulation schedules were tested for the Rotenberger Reservoir: 12.5 ft. - 14.0 ft. and 12.5 ft. - 14.5 ft. depth. A depth of 1.5 feet resulted in 6 out of 9 years. Under the 1.5 foot maximum regulated water depth, extended periods of more than 4 months without water in the pool were encountered in 2 out of 9 years; the pool was dry for 2 or 3 months in 4 out of 9 years; for 1 month in 2 of 9 years; and was wet all year in 1 of the 9 years. The 2 foot maximum water depth resulted in the pool being dry for more than 4 months in 1 of those years; for 2 to 3 months in 4 of the years; 1 month in 1 of the years; and wet all year in 3 of those years. Stage graphs for these schedules are shown on Figure 11.

Irrigation Recycling

None of the alternative regulation schedules tested has the capability to recycle all of the irrigation water supply requirements of the Miami and North New River Canal service areas. This finding was not unexpected, based on initial preliminary approximations made by the District earlier in the course of the Special Project studies. That portion of the total requirement not satisfied from the alternative retention area source will continue to be supplied from Lake Okeechobee. The most efficient recycling operation of the alternative retention area will be that used in the routing procedure described earlier herein; that is, all irrigation demands will be supplied from the Holey Land Reservoir until the available supply there is exhausted.

The following table presents the irrigation demand supplied from the Holey Land Reservoir at selected "drought" return periods:

Without Toe

Regulation Schedule	1 in 2 year (1972) Supply (A.F.)	% Total	1 in 5 year (1965) Supply (A.F.)	% Total	1 in 10 year (1973) Supply (A.F.)	% Total
12-17	145,200	79	128,600	55	104,900	42
12-16	136,300	74	126,900	54	103,500	41
12-15	109,100	60	124,000	53	76,800	31
12-14	57,600	31	95,300	41	46,500	19
13-17	87,300	48	86,400	37	82,200	33
13-16	60,200	33	85,400	37	53,900	22
			With Toe			
12-17	146,900	80	130,700	56	100,500	40
12-16	138,200	75	128,600	55	99,700	40
12-15	114,800	63	125,400	54	77,500	31
12-14	60,000	33	97,800	42	46,800	19
13-17	86,900	47	87,100	37	86,800	35
13-16	58,800	32	87,100	37	59.000	24

The "drought" return periods were based on ranking the historical yearly irrigation demands presented in Tables 3 and 4. Only the 10 years beginning in 1964 were considered for this determination to allow an initial period for filling the reservoir. The year with the largest demand was selected as representative of the 1 in 10 year drought. Similarly, the second largest demand and the fifth largest demand were selected as the 1 in 5 year and 1 in 2 year drought conditions.The

1 in 2 year, 1 in 5 year, and 1 in 10 year demands used in the above tables were respectively: 183,000 AF, 233,000 AF, and 250,000 AF.

A summary of monthly irrigation deliveries which would have been possible under past conditions is presented in Table 5. Tables 3 and 4 tabulate the monthly irrigation demand and allow a detailed comparison of deliveries with demand.

The observation may be made that the addition of the toe area which adds 12% to the surface area of the reservoir generally increases the percentage of the demand supplied by only 1% to 2% and occasionally decreases the amount of water which can be supplied. There are several factors contributing to this situation: (1) During rather extreme drought conditions rainfall during the latter portion of the wet season is insufficient to fill the reservoir to the desired regulation schedule. In this case the smaller reservoir reaches somewhat higher maximum stages than the larger reservoir. (2) During less severe drought conditions there is often excess water available for several days at a time during the irrigation season which allows replenishing, to a larger degree, the storage deficiencies incurred in the smaller reservoir while still not exceeding the selected maximum monthly regulation stages. (3) A level pool was assumed at all times in the reservoir. This assumption is not strictly valid at lower stages and may introduce an error on the order of ±500 acre-feet in annual irrigation deliveries.

Flow-through Water Distribution

In other sections of this report the value of using the Holey Land Reservoir and its appurtenant structures as a "flow-through" mechanism for the better distribution of water to the conservation areas has been indicated. Summarizing here, that value can be expressed as (1) better distribution of water over the northern portion of Conservation Area No. 3A east of C-123, and (2) the diversion away from Conservation Area No. 2A of some portion of the water now being pumped into that area at S-7.

The maximum monthly amount of water that could be re-routed to the northern portion of Conservation Area No. 3A is given in Table 6. Monthly minimum discharges at S-7 and S-8 under this type of operation are given in Tables 7 and 8. Monthly pumping into the Holey Land Area to meet these requirements is presented in Table 9.

A gross summary of the tables mentioned above, ignoring the effects of the particular regulation schedule selected, indicate (1) Flows at S-7 and S-8 will not be greatly affected by the Holey Land Reservoir. (2) Redistribution of flows in Conservation Area No. 3A will be slightly less than 50% of the combined flow of S-7 and S-8. (3) The total amount of water pumped to the Holey Land Reservoir will be slightly larger than the combined flow at S-7 and S-8.

<u>Spillway and Pump Sizes</u>

The pump sizes for the various regulation schedules tested were selected by beginning test runs with the routing program with deliberately oversized pumps. The capacity of the pumps was reduced on subsequent runs until a significant difference in yearly stages was noted or a significant reduction in the capacity of the system to deliver irrigation demands was encountered. It should be noted that this procedure will not necessarily size the pumps for the maximum cost-benefit ratio.

The pump sizes for the Holey Land Reservoir were determined by this procedure to be 2 - 750 cfs pumping stations for regulation schedules reaching 17.0 ft.msl., 2 - 650 cfs pumping stations for regulation schedules reaching 16.0 ft.msl., and 2 - 550 cfs pumping stations for all other regulation schedules. These pump sizes were not significantly affected by the addition of the "toe" to the reservoir area.

Pumping into the Holey Land Area was required on an average of 110 days per year in order to provide only enough inflow to maintain stages near optimum. In order to provide the maximum amount of flow re-direction to Conservation Area No. 3A, a total of 160 days per year was required.

When the additional pumping into the Holey Land Reservoir was instigated for flow redirection in Conservation Area No. 3A, the amount of pumping required at S-8 and S-7 was reduced. Pumping through S-7 and S-8 would have been required on an average of 320 days per year with the proposed channel improvements (hump removal) and the consequent re-direction of flows away from Lake Okeechobee, but without the Holey Land Reservoir area. Only 130 days would be required using the Holey Land Reservoir strictly as a retention pool and 120 days if maximum flow redistribution in the Conservation Areas were required ("flow-through" operation).

Pumping to the Rotenberger Reservoir for the 12.5 - 14.5 regulation would be required for 41 days. Table 10 presents a monthly summary of volumes pumped to this reservoir. The 12.5 - 14.0 regulation requires 34 days of pumping. Required pump size for the Rotenberger Reservoir under either schedule is 300 cfs.

"Flow-through" water can be discharged to Conservation Area No. 3A from the Holey Land Reservoir into the L-5 borrow canal through existing culverts. Ten 72-inch culverts are required to allow maximum redistribution of flows in Conservation Area No. 3A. There are presently ten culverts of this size at the south end of the Holey Land tract. Four of these culverts may require relocation in order to provide the desired redistribution.

The required spillway capacity could be decreased quite significantly by allowing S-7 and S-8 to handle more of the excess water; that is, to reduce "flow-through" discharge. A discharge capacity on the order of 700 or 800 cfs is sufficient to maintain stages at acceptable levels with minimal diversion of flows from S-7 and S-8 for "flow-through" discharge. However, since adequate outlet spillway capability already exists,maximum or near maximum flow-through capability based on the selected retention area pump capacities can be achieved at only moderate cost (addition of control gates to existing culverts).

ECOLOGICAL CONSIDERATIONS AND EVALUATION

An earlier section of this report, under the heading "Retention Areas", lists the various regulation schedules the performance of which in terms of filling and recycling was tested by means of the described routing procedure.

This section will discuss the factors (vegetation, fish, wildlife, and on-site water quality) of priority interest in Everglades ecology, specifically in relation to the Holey Land Reservoir alternates. The wide range of regulation schedules considered will be evaluated in terms of those ecological factors. Ecological considerations in the Rotenberger Reservoir area and the northern portion of Conservation Area No. 3A east of C-123 will also be discussed.

In order to present in a simple and readily understandable fashion the evaluation results a matrix ,(Figure 12) has been developed indicating the several water regulation schedules and their affects on vegetation, fish, wildlife and water quality in the Holey Land Reservoir. Many of these effects can be supported with existing data and analysis of hydrologic data. Evaluation of the other effects in the matrix is subjective, but based on considerable observation and discussion of known environmental components.

This dissertation will generally discuss each parameter in relation to the individual water regulations. Several of the ecological parameters are governed by either the high or the low side of these regulation schedules.

Wet Prairies

Wet prairie vegetation is presently minimal in the Holey Land. This is due primarily to the extended dry periods experienced during the past five years. Wet prairie habitat is available, and a nine or ten month hydroperiod (at the proper water depth) for two consecutive wet seasons will allow wet prairie recovery. This hydroperiod has been observed at two locations in Conservation Area No.3 (3-2 gage station and 3-4 gage station, Figure 13) which exhibit wet prairie dominance (as opposed to sloughs) in sites not occupied by sawgrass or tree islands. In the Holey Land this type of area is presently dominated by annual terrestrial plants such as dog fennel (Eupatorium capillifolium).

Wet prairies are an important part of Everglade ecology. They offer a diversity of plant communities that are necessary for many Everglade life forms. Small species of fish, crayfish, and fresh water shrimp necessary as food items for wading birds and larger fishes are abundant in wet prairies [1]. Seed production from plants commonly associated with wet prairies is important for waterfowl food.

The Holey Land will have wet prairie communities only at the lower regulation schedules (see Figure 12). The area must go dry for good wet prairie development. That is, the minimum side of the regulation schedule must be no higher than elevation 12.0 ft.msl. This schedule will dry most of the interior of the Holey Land excluding holes, depressions, or man-made canals.

Development of wet prairies is also governed by the high water stage and the period of inundation in an area. In the Holey Land, wet prairie plants will be absent with high water stages of 17.0 ft.msl. and above, even with a low water stage of 12.0 to dry the area. Excellent wet prairie communities found at the 3-2 and 3-4 gages in CA3 have had water depths exceeding 2.0 feet and 2.8 feet respectively for 10% of the time during the period 1963 to 1972. Poor wet prairie communities occur at the 3-28 gage in the south end of CA3 (Figure 13) where water depth exceeded 3.1 feet for 10% of the time from 1963 to 1972. Once wet prairie plant communities are established, they can withstand up to 31 consecutive months of flooding [2] with no permanent change in the community.

The marsh at the 3-28 gage was dry less frequently than the marsh at the 3-2 and 3-4 gages. The following table presents a comparison of the percent of the time the surface of the ground was wet during the four months when the water stages would ordinarily be lowest. During those four months the 3-28 gage site retained surface water more often than either the 3-2 gage or 3-4 gage locations.

Percent of time that end-of-the-month water stage exceeded ground level at three stations in CA3 (1963-1972 record)

Gage	March	April	May	June	Wet Prairie Development
3-2	40%	45%	78%	92%	Good
3-4	56%	42%	80%	90%	Good
3-28	80%	70%	92%	100%	Poor

This table also indicates that for optimal wet prairie conditions the marsh should be dry about 50% of the time by the end of March and remain dry through April. For optimum development of wet prairies, therefore, a schedule must be followed that dries the marsh by the end of March at least every other year.

March, April, and May are the months when the largest withdrawals of water are necessary for agriculture. However, agricultural interests commence substantial irrigation withdrawals in December. These withdrawals should allow a reduction in stage to effectively dry the Holey Land in most years (see Figures 10A and 10B).

Huntable Deer Herd

It is doubtful that any of the water regulation schedules shown on the matrix of Figure 12 will allow for a huntable deer herd. With the lowest schedule of 14.0 to 12.0, two feet of water will cover the ground for one month, and in excess of 18 inches of water will cover the area for probably more than three months.

Loveless (3) reports mature bucks feeding in water depths of 30 inches but clearly implies that adequate tree islands were available to the deer. Loveless also states, "Water depths which exceed two feet restrict does and young to high ground and hamper movements of the adult bucks." There is no high ground in the Holey Land to which the deer can retreat, so it can be stated with some degree of confidence that a 14.0 ft. maximum elevation (two foot depth) will eliminate deer as a huntable herd in the Holey Land.

In June and July of 1966, the Florida Game and Fresh Water Fish Commission entered into a massive deer rescue operation in the north portion of Conservation Area No. 3A when early summer rains flooded the Conservation Area and stressed the deer. This portion of the Conservation Area is considered prime deer range and, at that time, had a considerable number of excellent tree islands. The water depth at the 3-2 gage (location on Figure 13) ranged from 12 inches at the beginning of June to 27 inches by the end of July. Deer deaths were common in an area of abundant tree islands. The Game and Fresh Water Fish Commission recommended maximum water depth for the well being of deer at the 3-2 gage in CA3 (commonly referred to as the "Deer Gage") is 1.85 ft. Based on this criterion a two foot maximum water depth in the Holey Land presumably will not benefit the deer herd.

For a maximum deer herd the Holey Land water depth should fluctuate only about 1.5 feet, corresponding to a 12.0 to 13.5 ft.msl. schedule. The marsh should go dry during February for optimum fawn survival.

Fish Populations

If the area becomes slough oriented through an increase in the hydroperiod, all common south Florida species of fresh water fish will be plentiful. The low water stage of 12.0 ft. or 13.0 ft. will concentrate the fishes so that (a) larger fishes can eat smaller fishes, (b) fresh water angling for sport and food will be excellent and (c) wading bird feeding will be maximized as the lower stages are reached. Since the lowest ground elevations are slightly below 12.0 ft.msl. carryover water in the marsh will allow survival of some fish for annual repopulation.

The average size of one year old bass in south Florida is about 9.5 inches total length, and about 16.6 inches for female bass at the end of their second year.(4) Maintenance of a minimum schedule of 13.0 ft. for several years will produce a tremendous fish population in the Holey Land. However, this schedule will have adverse effects on plant diversity as it will not allow for periodic drying of the marshes. Also, if the water level should occasionally fall below 12.0 ft. or 11.0 ft., massive fish kills would occur. Public opinion will be adverse, to say the least. While criticism generated from occasional fish kills in an area such as Conservation Area No.2B can be withstood (there is nothing that can be done about them) it will be more difficult to explain a deliberate drying of the Holey Land (which will be necessary at times) and the temporary cessation of bass fishing in a 40 square mile area.

There are two alternatives to avoiding or alleviating this adverse public reaction and attendant accusations of mismanagement:

1. Dry the pool every year, never allowing growth of the fish population to the extent that it is large enough to elicit attention when it dies. This is not a particularly good solution because it deprives the citizenry of south Florida of what can be a magnificent fishing hole.

2. Provide sufficient deep water habitat to allow survival of large fish during a severe drawdown. This second alternative allows rapid fish repopulation of the area and also concentrates fish for the anglers who will use the area.

Internal canals aligned in an east-west direction would be most desirable for this end. These canals should not be drainage canals. They should not be designed to move water north or south, which would negate the nutrient removal benefits of the sawgrass marsh. An excellent compatible use of the Holey Land Reservoir area can be made by the provision of such facilities either as a part of the initial construction program, or at a later date.

Two construction designs for the Holey Land are compared to determine the effects of the different water management schedules on sport fishing (Figure 12). The design based only on engineering consideration calls for a minimum of deep water habitat; that is, only those canals necessary to allow water to enter or be discharged from the area.(See Figure 5). Under this design, the 13.0 ft. minimum schedule is most favorable to sport fishing in that it retains a foot of water in the marsh at low pool and provides for very high survival of sport fishes for the anglers. The 12.0 ft. minimum allows the fish population to be severely depleted annually as the marsh dries, with only the southernmost discharge canal and the northern get-a-way canals as fish reservoirs.

A design that incorporates extra construction of deep water canals will improve the fishery under all water regulation schedules. Studies have indicated that canals running through marshes that dry occasionally are capable of holding up to 1670 lbs. of fish per acre during the low water period.[4]

Everglade Kite

The Everglade kite is considered in this report because it is one of the rarest birds in the United States and confined almost exclusively to south Florida. Water management on the Holey Land Tract may have a direct effect on the Everglade kite population.

The primary food item of this bird is the apple snail (*Pomacea paludosa*), a large snail found abundantly at times in the Everglades. The Holey Land is not presently used by the Everglade kite. The droughts and the unstable water conditions on this area preclude a large *Pomacea* snail population. Everglade kites require large inundated areas (wet prairies or sloughs) which maintain a constant snail supply. A prolonged hydroperiod in the Holey Land which allows survival of the snail population and elimination of invading terrestrial plants will be of benefit to Everglade kites.

The kite portion of the matrix has been divided into two categories - resident and transitory. The resident boxes checked mean that the kite may establish a permanent breeding population. The transitory boxes checked indicate that Everglade kites can use the area on an annual basis but may not be able to successfully nest there. Schedules that have a 12.0 ft. minimum will all support a transitory population, while the 13.0 ft. minimums will support a resident population. The reasoning here is that extremely low surface water stages and actual drying of the marsh remove the snail supply from the kites. The snails burrow into the bottom muds as areas go dry. Snails are hidden by collapsed vegetation when water is shallow. Both conditions effectively remove the prey from the predators' sight and grasp.

Low water conditions in May 1967 forced Everglade kites in Conservation Area No. 2A to feed along the L-35B borrow canal. The water depth in the marsh of Conservation Area No.2A dropped to less than eleven inches during that period. Low water conditions in May and June of 1971 and 1972 concentrated a portion of the Everglade kite population along the Tamiami Trail Canal along the southern border of Conservation Area No.3 and the L-67A borrow canal (Figure 1) which traverses Conservation Area No.3 in a northeast-southeast direction. The kites fed effectively along the canal edges.

Everglade kite breeding season varies widely throughout the year depending upon climatic conditions, food, and nesting habitat availability. Kites usually nest from late February through mid-June. However, eight pairs of Everglade kites nested in Conservation Area 2A in July 1970, and kites have been reported nesting in November [5].

Retention of one foot of water in the Holey Land during the spring months of the year will provide a large continuous crop of snails for a resident population of Everglade kites on a year round basis.

<u>Waterfowl (Ducks)</u>

Waterfowl will use the area with any of the proposed water regulation schedules. The Holey Land Reservoir will also offer duck hunting in season under any of these schedules. The hunting will occur in the autumn through winter months when pool stages are high.

Water depth is critical to the species of duck using the area. Diving ducks (primarily ring-bills and scaup) will be the only ducks capable of using the area at all of the maximum regulation schedules being evaluated.

The puddle ducks common to south Florida (Florida mallards, blue-wing teal) depend on pothole type resting sites in a drying marsh with very shallow water depths.

The Conservation Area ecology is diverse enough with its sloping land elevations to offer habitat for both diving ducks and puddle ducks at the same time of most years. However, the Holey Land, with no typical slope to the land, will offer habitat for the different types of ducks at different times of the year. Diving ducks will occur in the winter and puddle ducks will occur in the spring (although they cannot be hunted at this time of year).

Wading Birds

The term "wading birds" is used here to include such species as great blue heron, wood stork, common egret, white ibis, glossy ibis, little blue heron, snowy egret, Louisiana heron, and several others. Those listed species and others are commonly found in south Florida wetlands and are classically associated with the Everglades.

Wading birds will be found in the Holey Land under all regulation schedules being evaluated in this report. All of these birds make use of lowering water depths and drying marshes for optimum feeding.

With a minimum elevation of 13.0 ft., wading birds will use the area in which to feed, but the food supply will not be sufficiently concentrated for optimum feeding conditions. With a minimum water elevation of 12.0 ft., ideal feeding conditions will occur as the water level is dropping from 13.0 ft. to 12.0 ft. Many thousands of wading birds will feed in the Holey Land Reservoir during the time the water stage is dropping that last foot.

Water Quality Benefits

These benefits are the least able to be quantified but accrue in two manners: (1) Removal from Lake Okeechobee of the nutrients presently being pumped via the S-2 and S-3 pump stations; and (2) removal of nutrients by vegetation as the nutrient laden waters are stored in or passed through the Holey Land.

Some evidence for removal of nutrients by a sawgrass marsh is available at this time (unpublished data, Flood Control District) and more is forthcoming under on-going District programs. Currently, it is conceded that the sawgrass marsh will remove nutrients from agricultural runoff. There are other actions in the marsh which will be useful in nutrient removal, but with the known capability of sawgrass to remove nutrients, it is imperative to retain the sawgrass in a healthy condition (see Sawgrass sub-section immediately following).

General water quality benefits will be derived from any of the schedules being examined. This parameter has been subjectively divided into two classes - high and low benefits (see Figure 12). The schedules that call for a maximum of 16.0 ft.msl. (four feet of water on the marsh) will provide better water quality than any of the schedules with a higher maximum level (17.0 ft.). This choice was made because water stages in excess of four feet may be detrimental to sawgrass. For optimal water quality, the general health of the sawgrass community must be assured.

Sawgrass

Sawgrass grows under a variety of ecological conditions in the Everglades. This is the one plant that truly characterizes the Everglades. Preliminary evidence (unpublished data, Flood Control District) indicates that sawgrass subjected to agricultural discharge can store up to 300% more phosphorus in its tissues than sawgrass receiving only rainwater.

Yates (6) found the best growth, tallest culms, greatest leaf width, and the greatest dry weight of standing crop of sawgrass in Conservation Area 2A at locations where the sawgrass was growing under almost permanently flooded conditions on peat soils. Sawgrass in Conservation Area No. 3 and Conservation Area No. 2B under conditions of shorter hydroperiod and shallower water depths was reduced in size and dry weight as compared to the sawgrass in Conservation Area No. 2A. Yates concluded that soil depth was less important to sawgrass growth than water depth. The sawgrass in Conservation Area No. 2A has withstood water depths of four feet for many years.

Because sawgrass does well in Conservation Area No.2A, the "yes" category for Healthy Sawgrass is selected in the matrix for all schedules to 16.0 ft. maximum elevation. The question marks in the 17.0 ft. maximum elevation category indicates that it is questionable that the sawgrass will remain healthy, even with an annual drying at 12.0 ft. There is no precedent available in the present Everglades to determine the annual effect of five feet of water on sawgrass. It is believed that six feet of water (18.0 ft. maximum) or higher will drown the sawgrass.

The Rotenberger Tract

This land lies immediately west of the Miami Canal and the Holey Land. Land elevations indicate that the Rotenberger area is slightly higher (0.5 ft.) than the Holey Land. With this assumption, the maximum and minimum water schedule elevations need only be raised one-half foot to achieve the same ecological projections as for the Holey Land. That is, a 14.5 to 12.5 schedule; a 15.5 to 12.5 schedule, etc.

The only alteration to be made in the matrix is that the "Yes" category for the Huntable Deer Herd may hold true under a 14.5 to 12.5 schedule. There may be sufficient tree islands in the Rotenberger Tract to offer refuge for the deer during the high water stages.

Conservation Area No. 3A

An important fringe benefit to a flow-through Holey Land - Conservation Area No. 3 system is the reduction of serious wild fires in the northeastern portion of Conservation Area No.3 (that area south of L-5 and east of C-123).

For the past five dry years rather serious fires have erupted in this section. Consequences have been destruction of large volumes of peat, smoke and haze along the heavily populated Gold Coast, and destruction and loss of portions of many of the tree islands which comprise not only one of the outstanding physical features of the Everglades but provide essential habitat for deer during wet periods.

The ultimate goal for this portion of Conservation Area No. 3A should be a nine to ten month hydroperiod of less than two foot maximum depth. This hydroperiod will exclude the terrestrial invading plants; promote the sawgrass-wet prairie marsh associations; eliminate the hot, peat-consuming wildfires; and help preserve the tree-islands. It will offer excellent waterfowl and wading bird habitat, and a diversity of plant communities that is necessary to Conservation Area No. 3A. The wintering wading bird populations depend upon drying marshes to provide the food that is necessary for nesting and rearing of young. Drying portions of the Everglades must be available throughout the dry season to provide a sufficient food supply. Classically, the birds use the northern end of Conservation Area No. 3 first, and follow the drying marshes southward throughout the dry season. Extension of the Holey Land impoundment into Conservation Area No. 3A, and/or sub-impoundments in the northern portion of Conservation Area No. 3A or in the northerly apex of Conservation Area No. 2A for water storage would destroy large areas of potential wet prairie plant communities and tip the scales heavily in favor of aquatic slough communities. Sufficient deep water Everglades habitat is already available in the southern portions of Conservation Areas Nos. 1, 2A, and 3A. There is already evidence to indicate that Conservation Area No. 2A is "too wet".(7)

The Conservation Areas of the Central and Southern Florida Flood Control District are of national importance as vestiges of the original Everglades. The ecology of the existing Everglades has been altered in some areas. It is vital at this time to maintain large areas of maximum diversity within the existing system, and to avoid the aquatic ecology with limited diversity that would result in the northeast quadrant of Conservation Area No. 3 or the northern apex of Conservation Area No. 2A by impoundment for the single purpose of water storage.

Plant Species

The following is a list of plant species which commonly occur on the Northern Everglades wet prairies:*

Rhynchospora tracyi	Beak-rush
inundata	Water-rush
Panicum hemitomon	Maidencane
paludivagum	Water Panicum
Eleocharis cellulosa	Spike-rush
elongata	Spike-rush
Sagittaria lancifolia	Arrowhead
Pontederia lanceolata	Pickerel-weed
Bacopa caroliniana	Water Hyssop
Nyphaea odorata	White Water Lily
Nymphoides aquaticum	Floating Heart
Crinum americanum	Swamp Lily
Hymenocallis floridana	Spider Lily
Utricularia spp.	Bladderworts
Oxypolis filiformis	Water Drop-wort
Eriocaulon compressum	Pipewort
Peltandra virginica	Green Arum
Cladium jamaicensis	Sawgrass
Psilocarya nitens	Bald-rush
Pluchea foetida	Marsh Fleabane
Sacciolepis striata	False Maidencane
Cyperus haspan	An Umbrella Sedge
Ludwigia repens	Floating Ludwigia
Lachnanthes caroliniana	Red-root
Xyris spp.	Yellow-eye-grass

*Goodrick, Robert L. 1974. The Wet Prairies of the Northern Everglades. In Environments of South Florida. Miami Geological Society Memoir No. 2, p. 48.

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REQUIRED SYSTEM FACILITIES

Flow Re-Direction

This portion of the system requires the enlargement ("hump removal") of both the Miami and North New River Canals, and the provision of a flow regulation structure in the North New River Canal near its confluence with the Hillsboro Canal.

The design channel sections for the Miami and North New River Canals are shown on Figures 2 and 3. From the data shown on these figures it is estimated that the Miami Canal enlargement will require the excavation of 2,400,000 C.Y. of material and that 1,450,000 C.Y. of excavation will be required for the North New River Canal enlargement.

The flow regulation structure in the North New River Canal will be a one-bay reinforced concrete gated spillway with a submerged crest. The gates will be vertical-lift gates.

Holey Land Reservoir

The general layout of the facilities required for this reservoir are shown on Figure 5.

The specific design of several elements of this reservoir will be dependent on the regulation schedule which is selected; i.e., the perimeter levees, the pumping stations, and the intake channel from the North New River Canal.

Perimeter levees will be required only on the north, east and south sides; the existing levee of the Miami Canal on the west side being adequate in grade and cross-section for all considered regulation schedules. The south perimeter levee is to be located north of the existing FP&L transmission line, at a distance approximately 450 ft. north of the L-5 interior levee which also serves as the access road to both S-8 and the transmission line towers. The basic criteria for levee design, regardless of the regulation schedule selected are:

1. Ten foot crown width.
2. Side slopes of 1V on 2H.
3. Two feet of freeboard above maximum regulation schedule stage, except 1.5 ft. for the 14.0 ft. maximum schedule.
4. "Coring" of levee by removal of muck under the middle 10 feet of the levee base; muck thickness determined by borings to be three feet on north side and two feet on south side.

The total length of required levee construction is 20.5 miles.

Prior to detailed levee design precedent to preparation of contract plans for construction further seepage studies and analyses will be conducted in order to determine the necessity for providing a head pressure relief system along the north and east perimeters.

Pumping station size was determined by the method described in a previous section of this report. (See page 35). To summarize here the requirements are:

17.0 ft. maximum regulation stage - 2 pumping stations at 750 cfs each.

16.0 ft. maximum regulation stage - 2 pumping stations at 650 cfs each

All other schedules - 2 pumping stations at 550 cfs each

The size of the intake channel from the North New River Canal will be dependent upon the pumping station size. The intake channel will be leveed on both sides, tied in to the North New River Canal levee on the east and to the retention area levees on the west. Design levee grade will be at 17.5 ft.msl., the design grade of the North New River Canal levee. Channel size will be governed by required intake capacity rather than levee requirements. Channel design criteria are an 11.0 ft. stage in the North New River Canal and 9.0 ft. at the pumping station.

The intake channel will be an open connection to the North New River Canal and hence a bridge in U. S. Highway No. 27 over the channel will be necessary. A detour road during bridge construction will be required for maintenance of highway traffic.

Embankment material for the levee construction will be taken from adjacent continuous borrow canals. On the north and east sides the borrow canals will serve as seepage collectors. At the northeast corner of the retention area gated 42-inch culverts connecting the north and east borrow canals with the pumping station intake channel will be provided. Seepage collected by these borrow canals will be discharged to North New River Canal via these culverts, which can be regulated as necessary to maintain seepage control.

The south perimeter levee borrow canal will be placed on the retention area side. In this location it will serve, at low stages, to concentrate the fishery resources of the area.

No additional outlet capacity southward to Conservation Area No. 3 will be required, the existing outlets being adequate. These consist of a four barrel 72-inch culvert installation 0.6 miles east of S-8, and a six barrel 72-inch culvert installation 3.5 miles east of S-8. The flashboard risers on all culverts will be replaced by gates.

Tieback levees from the south perimeter levee to these culvert installations will be provided. "Flow-through" discharge, or emergency relief discharge, will be from these culverts into the L-5 borrow canal. The L-5 exterior levee will be gapped at a number of locations to distribute overland flow to the adjacent portion of Conservation Area No. 3A.

After a period of operation it may prove necessary or desirable to either relocate some of the existing culverts, or add culverts, if flow distribution under the arrangement described herein is not satisfactory.

The existing "divide" structure in the L-5 borrow canal will be relocated 3 miles to the east; that is to the east line of the "toe". This will permit distribution of "flow-through" discharge along a greater length of Conservation Area No. 3A. The relocated structure will contain a gated 84-inch culvert. This structure will provide operational flexibility and can also be used as an emergency relief facility for the reservoir, directing flows to S-7.

Flashboards will be placed in the existing box culvert at the west end of the L-5 borrow, connecting with the Miami Canal above S-8.

Holey Land Reservoir - With Toe

All facility requirements for a retention area having this configuration are precisely the same as identified for the reservoir having the basic configuration except for the length of required levees. A net additional 6.0 miles of levee is required, making the total levee length 26.5 miles. (Figure 7)

Auxiliary Facilities (Holey Land Sites)

A previous section of this report (see page 42) indicated the desirability of constructing canals having an east-west orientation in order to concentrate fishery resources during low water periods. This feature would be particularly desirable with those regulation schedules having a lower limiting stage of 12.0 ft.

It is considered that any canals provided for this purpose should have a minimum depth of 12 ft. below natural ground surface and a top width of approximately 50 feet. The associated adjacent spoil areas should be gapped at frequent intervals.

Rotenberger Reservoir

The general facilities layout is shown on Figure 8.

Levee design criteria are the same as for the Holey Land sites; the only exception being the requirement for "coring" which is waived in this case due to the small heads across the levees.

Levees will be required on the north, west and south perimeters; the existing Miami Canal levee on the east side being adequate with a crown width of 10 feet at a minimum grade of 19.0 ft.

Total length of required levee is 16.1 miles.

The levee borrow canals on the north, west and south sides will be placed on the outside and will act as seepage collectors. A ditch on the east side, inside the Miami Canal levee, will also be required. This ditch is necessary in order to collect and distribute water entering and leaving the reservoir. The low regulatory stages contemplated for this reservoir make this facility necessary.

A 42-inch culvert with gate will be located in the eastern end of both the north and south levees to discharge seepage into the Miami Canal and maintain water levels as required. One 72-inch culvert with gate will be placed through the existing Miami Canal west levee to discharge excess storage via the collector ditch. Two gated 72-inch culverts approximately six miles above S-8 will serve the same purpose.

A 300 cfs pump located in the Miami Canal West levee will deliver re-directed water from the S-3 basin into the reservoir as determined by the regulation schedule adopted. Two 72-inch culverts at this pumping station will act to discharge excess water via the collector ditch.

FIRST COSTS

General

First costs for construction are based on current (1975) contract prices and include a 12% allowance for contingencies. First costs for land acquisition in the reservoir areas are based on the District's interpretation of appraisal values developed during the course of the State's consideration of acquiring the in-holdings in the Rotenberger Tract.

Flow Re-direction Facilities

Miami Canal:	channel excavation	-	$ 4,025,000
North New River Canal:	channel excavation	-	2,450,000
	flow regulation structure	-	720,000
	Sub-Total NNRC	-	$ 3,170,000

Total System Cost: $7,195,000

Holey Land Reservoir

Pumping station, intake channel and perimeter levee construction costs will vary dependent on the water management schedule used (see page 52). The cost of all other required facilities will be the same regardless of the regulation schedule. These items of cost, which are the "fixed" costs for all alternative schedules are listed below:

Item		Construction Cost
2-42" culverts in seepage ditches	-	$ 10,000
Gating existing L-5 culverts	-	150,000
1-84" culvert in L-5 borrow canal	-	25,000
Gapping L-5 levee and constructing tie-backs	-	20,000
Intake canal levees	-	96,000
Bridge at U.S.Highway #27	-	150,000
2-72" culverts at each pumping station	-	180,000
Sub-total	-	$ 631,000
12% contingencies	-	76,000
Total	-	$ 707,000

The variable costs, related to regulation schedule, are listed below:

Item	Construction Costs 17.0 ft. max.	16.0 ft.max.	15.0 ft.max.	14.0 ft.max.
Pumping Stations	$ 4,360,000	$4,040,000	$3,720,000	$3,720,000
Perimeter levees	1,759,000	1,498,000	1,112,000	920,000
Intake canal	596,000	535,000	482,000	482,000
Sub-total	$ 6,715,000	6,073,000	5,314,000	5,122,000
12% contingencies	806,000	729,000	638,000	615,000
Total	$ 7,521,000	$6,802,000	$5,952,000	$5,737,000

For all alternatives lands will have to be acquired for: (a) the intake canal, and (b) the privately owned lands in the Rotenberger Tract east of the Miami Canal (1,500 acres). These costs are:

Item		Land Cost
Intake Canal R/W		$ 103,000
*Reservoir lands		975,000
Total	-	$1,078,000

*1,500 acres at $650/acre.

The summary of estimated first costs for the regulation schedules considered is given in the following tabulation:

Schedule	Constr. Cost	Land Cost	Total First Cost
12'-17'	$ 8,228,000	$ 1,078,000	$ 9,306,000
12'-16'	7,509,000	"	8,587,000
12'-15'	6,659,000	"	7,737,000
12'-14'	6,444,000	"	7,522,000
13'-17'	8,228,000	"	9,306,000
13'-16'	7,509,000	"	8,587,000

Holey Land Reservoir - With Toe

The construction costs for this reservoir configuration will be the same as those for the basic reservoir configuration except for the cost of perimeter levee construction, which will be greater with the toe added. The additional levee length is 6.0 miles. Land costs for this configuration will be the same as for the basic configuration.

Increased levee costs (construction cost plus 12% for contingencies) are as follows:

17.0 ft. max. stage	-	$ 515,000
16.0 ft. max. stage	-	438,000
15.0 ft. max. stage	-	325,000
14.0 ft. max. stage	-	269,000

The summary of estimated first costs is given in the following tabulation:

Schedule	Constr. Cost	Land Cost	Total First Cost
12'-17'	$ 8,743,000	$ 1,078,000	$ 9,821,000
12'-16'	7,947,000	"	9,025,000
12'-15'	6,984,000	"	8,062,000
12'-14'	6,713,000	"	7,791,000
13'-17'	8,743,000	"	9,821,000
13'-16'	7,947,000	"	9,025,000

Rotenberger Reservoir

The perimeter levees will be the only item of cost which will vary with the regulation schedule used.

Land acquisition will involve 6,670 acres at an estimated cost of $450/acre.

First costs are tabulated below:

Item	Schedule 12.5'-14.0'	Schedule 12.5'-14.5'
1-300 cfs pumping station	$ 1,040,000	$ 1,040,000
Discharge culverts	80,000	80,000
Collector ditch	335,000	335,000
Perimeter levees	631,000	754,000
	$ 2,086,000	$ 2,209,000
12% contingencies -	250,000	265,000
Sub-total construction -	2,336,000	2,474,000
Land cost	3,002,000	3,002,000
Total -	$ 5,338,000	$ 5,476,000

Auxiliary Facilities

Fish concentration channels of the type and dimensions described on page 54 for the Holey Land reservoir site(s) will have a first cost for construction of $90,000 per mile.

ANNUAL COSTS

General

Annual costs consist of two components: (a) amortization of first costs, and (b) cost of operation of system facilities.

Amortization has been taken over an estimated 30-year project life. Use of this term makes the date of project payout closely approximate the payout date of the C&SF Project for the Everglades Agricultural Area for which a 50-year life was assumed when the Project was authorized. In addition, it appears that at or near the end of that period the nature and character of agricultural land use in the study area will change as a result of further muck subsidence. Two interest rates have been used for comparative purposes: 5 7/8 %, the value currently being used by the Corps of Engineers,and 7%, the rate recommended by the Water Resources Council for water resource development projects.

Costs of operation and maintenance are based on the District's cost experience for the operation and maintenance of similar facilities under the C&SF Project. In determining the annual operation and maintenance costs the fuel cost component of the pumping station O&M cost has been excluded. The total volume of runoff water to be pumped will remain approximately the same; consequently this cost is not chargeable to the plan considered in this report. The pumping station O&M costs listed are, therefore, incremental costs over the District's present costs for O&M at S-2, S-3, S-7, and S-8.

Similarly, neither the amortized first costs nor the annual maintenance costs of the Miami and North New River Canals are presented. These are features which will be provided under the C&SF Project in any event and hence are not properly chargeable to the plan being evaluated herein.

Holey Land Reservoir

Annual costs are tabulated below:

Schedule	Amortization 5 7/8%	Levee & Struct. Maint. & Op.	P.Sta. O&M	Total	Amort. increment 7%	Total
12'-17'	$ 667,100	$ 8,100	$ 91,000	$766,200	$ 82,900	$ 849,100
12'-16'	615,500	7,400	86,000	708,900	76,400	785,300
12'-15'	554,600	6,600	86,000	647,200	68,900	716,100
12'-14'	539,200	5,400	70,000	614,600	67,000	681,600
13'-17'	667,100	8,100	96,000	771,200	82,900	854,100
13'-16'	615,500	7,400	91,000	713,900	76,400	790,300

Holey Land Reservoir - With Toe

Annual costs are as follows:

Schedule	Amortization 5 7/8%	Levee & Struct. Maint. & Op.	P.Sta. O&M	Total	Amort. increment 7%	Total
12'-17'	$ 704,000	$10,200	$ 91,000	$805,200	$ 87,500	$ 892,700
12'-16'	646,900	9,300	86,000	742,200	80,400	822,600
12'-15'	577,900	8,200	86,000	672,100	71,800	743,900
12'-14'	558,500	6,700	70,000	635,200	69,400	704,600
13'-17'	704,000	10,200	96,000	810,200	87,500	897,700
13'-16'	646,900	9,300	91,000	747,200	80,400	827,600

Rotenberger Reservoir

Annual costs are as follows:

Schedule	Amortization 5 7/8%	Levee & Struct. Maint. & Op.	P.Sta O&M	Total	Amort. increment 7%	Total
12.5'-14.0"	$382,700	$ 3,900	$ 52,000	$438,600	$ 47,600	$ 486,200
12.5'-14.5"	392,500	5,500	56,000	454,000	48,800	502,800

PLAN EVALUATION

Retention Area Filling Capability

The flow re-direction design tested in this study has the capability of directing away from the Lake an average annual volume of 203,910 A.F. of runoff water that originates in the study area.(See page 22). This is a reduction of 94% of the water which is currently being pumped to the Lake from the Miami and North New River Canal basins. This is considered to be excellent performance in terms of accomplishing the objectives of the Special Project.

Filling of the reservoir will be accomplished during the wet season: June through October. Reservoir replenishment can, and will, take place during the dry season when runoff occurs. This replenishment will not exceed the stage prescribed by the descending limb of the regulation schedule. However, the critical volume in terms of filling performance is the amount of water which will be available in the wet season. Performance is evaluated on this basis.

A major constraint on the filling of the Holey Land reservoir should be that the conservation areas continue to receive approximately the same volume of wet season flows with the Holey Land Reservoir in operation as they have received historically by way of S-7 and S-8. Under this constraint the average wet season volume available for filling is that which has been directed away from the Lake; i.e., 141,290 A.F. (See page 22). With the flow re-direction system operating at 94% effectiveness it is considered, then, that the maximum amount of water has been made available for reservoir filling.

Filling performance is dependent upon: (a) the amount of water available for filling, (b) size of the retention area, (c) maximum reservoir depths and, (d) filling schedule constraints. As indicated above, excellent flow re-direction performance is achieved with the proposed design. Since the maximum amount of water has been made available for filling, evaluation can then be based on the combination of reservoir size, pool depths, and regulation schedule constraints.

Filling performance of various regulation schedules,having the constraint of a maximum one foot rise in June, is presented by the stage graphs for the Holey Land Reservoir of Figures 10A, 10 B, and 10C. Filling performance at the lower maximum water depths of 2.0 ft. and 3.0 ft. (Figure 10B) is excellent, in all years except one required October reservoir stage is achieved. However, not all of the available water will be used for filling and, particularly with the 12.0'-14.0' schedule, more water than under historical conditions will be passed on into the conservation areas.

With 4.0 ft. and 5.0 ft. maximum water depths for the Holey Land Reservoir (Figures 10A and 10C) filling performance is dependent on the minimum draw-down stage. The 13'-17' schedule shows filling in 10 out of 11 years, whereas with the 12'-17' schedule the reservoir is filled in only seven of eleven years. Both of the 16' maximum schedules indicate good filling performance; i.e., 10 out of 11 years. In these cases a greater amount of the available water is used for reservoir filling and flows to the conservation areas more closely approximate the historical.

The filling characteristics of the Rotenberger Reservoir are indicated on the stage graphs of Figure 11. The flow routings on which these graphs are based required that water be placed in the Rotenberger Reservoir only after the requirements of the Holey Land Reservoir under the 12.0'-16.0' schedule are met. Performance is excellent under the 12.5'-14.0' schedule. However, these water requirements are very nearly met by the excess of wet season rainfall over evapotranspiration, which averages about 15 inches (See Tables 1 and 2). Performance is good under the 12.5'-14.5' schedule, but stages fall slightly short of schedule in about half the years due to the priority of filling the Holey Land Reservoir.

Water can be furnished to both the Holey Land Reservoir and the Rotenberger Reservoir with good to excellent performance characteristics under all the regulation schedules tested in this investigation.

The filling performance of the Holey Land Reservoir with all regulation schedules tested is good to excellent. The Holey Land Reservoir is at about optimal size, when considering filling characteristics only, under the 15.0 ft, 16.0 ft, and 17.0 ft. maximum schedules.

The real significance of filling performance can only be determined, however, in relation to irrigation water recycling capability. This is discussed in the following sub-section.

Irrigation Water Recycling Capability

The table presented on page 33 furnishes pertinent quantitative information concerning performance of various combinations of Holey Land Reservoir configurations and regulation schedules tested. The values listed in the 2nd and 3rd columns indicate recycling performance under the median condition of irrigation season rainfall and the 6th and 7th columns the performance during "dry" irrigation seasons. A moderately dry condition is indicated by the values in the 4th and 5th columns.

It is clear from this table that, regardless of reservoir configuration, the performance of the 12'-15', 12'-16', and 12'-17' schedules is significantly better than the performance of the other schedules tested. Assuming all other evaluation factors to be equal, these three should be more closely examined to determine whether one is clearly superior.

For the moderately dry condition there is no marked distinction in performance. Under median or "dry" conditions, however, the 12'-15' schedule shows an inferior performance. Under these same conditions there is comparatively little difference between the 12'-16' and 12'-17' schedules. This indicates that during most irrigation seasons (except the "wet" ones) the 12'-16' schedule will perform just as well as the 12'-17' schedule. The significance of better performance during "wet" irrigation seasons is minimal since under such conditions it is likely that ample water will be available in Lake Okeechobee to meet irrigation requirements.

The apparent anomaly of equivalent performance of the three schedules for the moderately dry condition (1965) is explainable by the heavy demand which occurred early in the season that year. With a more "normal" pattern of monthly distribution of irrigation demand it is likely that the 12'-15' schedule would show a somewhat inferior performance for the moderate condition similar to that which it shows for the median and very dry conditions.

This analysis of the data summarized in the table on page 33, produces a ranking of the tested regulation schedules as follows:

1. 12'-17' and 12'-16'
2. 12'-15'
3. 13'-17'
4. 12'-14' and 13'-16'

These performance data do not show any selection preference between the Holey Land Reservoir with or without the "toe".

Unit Cost of Recycled Water

The following table lists the average recycled irrigation water volumes for the regulation schedules tested for the Holey Land Reservoir, with and without the toe. The average irrigation demand for the study area is 179,500 A.F.

	Without Toe		With Toe	
Schedule	Supply (A.F.)	% Average Demand	Supply (A.F.)	% Average Demand
12'-17'	103,100	57%	104,100	58%
12'-16'	98,300	55%	99,900	56%
12'-15'	84,700	47%	86,900	48%
12'-14'	58,900	33%	59,800	33%
13'-17'	69,800	39%	69,800	39%
13'-16'	57,800	32%	57,600	32%

Using the first costs and annual costs presented on pages 60 and 62, and the above average recycled irrigation water volumes, the costs per unit of recycled water for each alternative considered are given below:

	Unit Costs ($/A.F.)			
	Without Toe		With Toe	
Schedule	First Cost Basis	Annual Cost Basis (5 7/8%)	First Cost Basis	Annual Cost Basis (5 7/8%)
12'-17'	90.30	7.40	94.30	7.70
12'-16'	87.40	7.20	90.30	7.40
12'-15'	91.40	7.60	92.80	7.70
12'-14'	127.40	10.40	130.30	10.60
13'-17'	133.30	11.10	140.70	11.60
13'-16'	148.60	12.40	156.70	13.00

Average supply values, rather than median supply values (1 in 2 year condition, table on page 33), were used for this unit cost analysis. Use of the median supply values would have produced lower unit costs, but it was believed to be more appropriate to use average annual supply values in conjunction with average annual cost.

There is a definite grouping of regulation schedules based on unit cost values. As in the case of recycling performance, the 12'-17', 12'-16' and 12'-15' schedules fall into a clearly superior category in terms of cost-effectiveness both on a first cost and on an annual cost basis. The ranking of the cost-effectiveness of the six schedules and two reservoir configurations considered is as follows (annual basis):

1. 12'-16' w/o toe
2. 12'-16' with toe and 12'-17' w/o toe
3. 12'-15' w/o toe
4. 12'-17' with toe and 12'-15' with toe
5. 12'-14' w/o toe
6. 12'-14' with toe
7. 13'-17' w/o toe
8. 13'-17' with toe
9. 13'-16' w/o toe
10. 13'-16' with toe

The differences between the top four combinations (items 1, 2 and 3), however, are not large enough to establish any clear superiority of one over another. In view of this, pragmatic considerations of lowest total first cost will carry some weight in plan selection.

A unit cost analysis of the Rotenberger Reservoir was not made since the usefulness of that reservoir for recycling irrigation water under the regulation schedules considered is minimal, at best.

Effect on Lake Okeechobee Water Budget

Routings for Lake Okeechobee were conducted by the District in connection with its water supply planning studies. The proposed new regulation schedule of 15.5 ft. - 17.5 ft. for the Lake was used for these routings. One set of routings assumed that all backpumping to the Lake at S-2 and S-3 (average annual volume of approximately 350,000 A.F.) was terminated and that the alternative reservoir site(s) would supply 75% of the average irrigation demand of the area (a supply of approximately 260,000 A.F.). The net effect is an increase of 90,000 A.F. in the average yearly demand on the Lake's water supply. The routings made under these conditions were based on 1970 and 1985 levels of estimated demands on the Lake's supply.

These routings showed that Lake stage would be approximately 0.2 ft. lower at the 1985 demand level throughout a wide range of normal stages. The critical Lake stage of 10.5 ft.msl. would occur about 1% more of the time under this regimen.

The 12.0'-15.0', 12.0'-16.0', and 12.0'-17.0' retention area schedules considered herein will place an average annual increased demand on the Lake of 75,000 to 95,000 A.F. This is comparable to the increased demand of 90,000 A.F. incorporated in the routings described above. Consequently, it is reasonable to conclude that under any one of these three schedules, the increased incidence of low Lake stages will not be significantly different than indicated by the routings. An approximate increase of 1% in the time that Lake stages would be at 10.5 ft. or below is acceptable in terms of water quantity management.

A corollary conclusion is that additional expenditures to obtain increased recycling capability are not justified.

<u>On-Site Ecological Impacts</u>

The impacts of alternative regulation schedules on several major environmental components have been presented in detail earlier and are indicated in the matrix of Figure 12. However, no weighting of those components was given in that discussion.

The most important consideration is the establishment and maintenance of a healthy sawgrass community. Based on this factor alone, schedules having a maximum regulatory elevation of 17.0 ft, can be eliminated from further consideration.

The maintenance of wet prairies is a consideration second in importance only to the maintenance of sawgrass. For this purpose, a schedule having a 12.0 ft. lower regulatory stage and permitting significant periods of "drying out", is required; thus eliminating schedules having a 13.0 ft. minimum stage.

The 12.0 ft. schedules, on the other hand, will have adverse impacts on the fishery in the retention area. A trade-off has to be made between wet prairies and the sports fisheries. It is our judgment that if such a trade-off must be made that it be in favor of wet prairies. However, a partial compensatory measure has been indicated; i.e., the construction of fish concentration canals. If these are provided, the 12.0 ft. schedules are clearly superior. In addition, the 12.0 ft. schedules are more favorable to another important environmental component; wading birds.

Another important component to be considered is a huntable deer herd. The earlier discussion questioned the ability to maintain a huntable deer herd even with the lowest schedule (12.0'-14.0') considered. In order to maintain a herd with certainty, a 12.0'-13.5' schedule would have to be adopted. The trade-off here is clearly between maintenance of a deer herd and provision of water recycling capability, since a 12.0'-13.5' schedule produces no recycling benefit.

Based on this evaluation of the several major ecological components, the schedules considered are ranked as follows, from most acceptable to least acceptable:

1. 12'-15', 12'-16'*
2. 12'-14'
3. 13'-16'
4. 12'-17'
5. 13'-17'

*12'-16' schedule is slightly less acceptable because a four foot water depth is close to the maximum observed limit of sawgrass growth.

Additional Considerations

The following factors were not included as part of the evaluation, but nevertheless add to the desirability of creating a water retention area on the Holey Land Tract: (a) arresting muck subsidence, (b) better distribution of water into the conservation areas, and (c) better control of fires.

All of the regulation schedules considered will, in most years, retain sufficient water in the muck profile to significantly slow the rate of subsidence that has occurred on the Holey Land in the past.

The Holey Land Reservoir, used as a "flow-through" system, will help to better distribute water along the north edge of Conservation Area No. 3A east of C-123. This will extend the hydroperiod on an area which has been dried out extensively in the past. The extension of the hydroperiod will reduce the hazard of vegetation and muck fires in this area.

In the Holey Land itself, the present shortened and unnatural hydroperiod will be substantially extended. Additionally, should muck fires occur there, the means will exist to introduce water for fire control purposes.

Evaluation Summary

1. Recycling performance evaluation favors either the 12'-17' schedule or the 12'-16' schedule.
2. Unit costs for recycled water, when considered in conjunction with total first costs, favor the Holey Land Reservoir without the toe.
3. Unit cost evaluation, both on first cost and annual cost bases, shows little difference between the 12.0'-17.0', 12'-16' and 12'-15' schedules, but slightly favors the 12'-16' schedule.
4. Evaluation of the impact on the Lake Okeechobee water budget indicates no significant distinction between the 12'-17', 12'-16', or 12'-15' schedules.
5. Evaluation of ecological factors favors the 12'-15' schedule, with the 12'-16' schedule being only slightly less favorable.
6. With the evaluation factors for several schedules being closely balanced, total first costs become a factor in plan selection.

RECOMMENDATIONS

Land Acquisition

A substantial portion of the initial cost of establishing a Holey Land Reservoir is the cost ($975,000) of acquiring the privately owned lands in the Rotenberger Tract east of the Miami Canal. It is reasonable to consider if alternatives are available for elimination of that component of the first cost.

Since the Holey Land "toe" contains approximately the same area as the Rotenberger Tract east of Miami Canal (3,780 acres vs. 3,580 acres) the "toe" area could be included in the Holey Land Reservoir and the Rotenberger area east of the Miami Canal excluded without altering the performance characteristics of the reservoir. This alternative trades off construction costs for land acquisition costs. A reservoir having this configuration would involve construction of an additional 6.0 miles of levee around the "toe", 6.0 miles of levee along the west boundary of the Holey Land Tract, and additional intake facilities at the Miami Canal. The estimated cost of these additional works is $810,000, $1,060,000 and $1,230,000 for the 15.0 ft., 16.0 ft., and 17.0 ft. maximum schedules, respectively. This option is viable only in the case of the 15.0 ft. maximum schedule if total first cost is the only consideration.

A second option involves the exchange of State-owned lands in the "toe" for the privately-owned lands in the Rotenberger Tract east of the Miami Canal on an equitable basis. A possible variation of this option is to exchange State-owned lands elsewhere for the Rotenberger Tract lands. The advantage of this option, or a variation thereof, is that no cash outlay will be required in order to assemble the lands required for the Holey Land Reservoir.

It is recommended that the Holey Land Reservoir be established in the configuration shown on Figure 5, and that the privately-owned lands required for this Reservoir be obtained by exchanging them for State-owned lands either: (a) in the Holey Land "toe", or (b) elsewhere in the State.

Reservoir Regulation Schedule

The evaluation summary on page 72, indicates that the choice of regulation schedule lies between the 12'-15' and the 12'-16' schedules. Recycling performance and cost-effectiveness (in terms of recycling capability) indicate a selection of the 12'-16' schedule.

However, recycling performance should be considered also in terms of effect on the Lake Okeechobee water budget. On an annual average basis the increased draft on Lake storage with a 12'-15' schedule for the retention area is 13,600 A.F. when compared with the 12'-16' schedule (See table on page 67). Experience and judgment indicate that ordinarily an increased draft of this magnitude is not significant. Its degree of significance will not be altered as future demands on Lake storage increase, since the implementation of the new regulation schedule for the Lake will increase Lake storage capability. Accordingly, although cost-effectiveness considerations based on recycling performance indicate a preference for the 12'-16' schedule for the retention area, cost-effectiveness is not an over-riding factor in comparing the 12'-16' schedule with the 12'-15' schedule.

The charge under which this investigation was undertaken was interpreted to mean that the optimal overall plan be developed. This report indicates that significant advantages to fish resources and to the public would accrue from construction of fish concentration canals within the Holey Land Reservoir. The 12'-15' schedule first costs for reservoir construction are $850,000 less than the costs for the 12'-16' schedule. If a portion of these savings are applied to the construction of fish concentration canals a better overall multi-purpose plan, with little or no sacrifice of other important values and considerations, will result.

It is recommended that the 12'-15' regulation schedule be adopted, and that the construction of six miles of fish concentration canals (to the dimensions specified in this report) at an estimated cost of $540,000 be incorporated in the initial construction of the Holey Land Reservoir system.

Flow Re-direction and Retention Area Facilities

It is recommended that "hump removal" enlargement of the Miami and North New River Canals be to the capacities which have been established by the Corps of Engineers for Lake regulation purposes; i.e., 2000 cfs capacity in the Miami Canal and 1600 cfs capacity in the North New River Canal.

It is further recommended that the construction of the canal enlargements be placed in a high priority category for funding under the Central and Southern Florida Project.

It is also recommended that the retention area facilities for the Holey Land Reservoir operating under a 12'-15' regulation schedule be provided as described in this report.

The Rotenberger Tract

A retention area on that portion of the Rotenberger Tract west of the Miami Canal has limited usefulness, if any, as an irrigation water re-cycling facility at the regulation schedules considered and tested. As indicated earlier in this report it does not appear practicable to consider management of this area for values other than maintenance of a huntable deer herd. In addition, it is not considered justifiable in terms of need or cost-effectiveness to spend in excess of $5 million for at best a marginal increment in recycled water which would only be available, if at all, at the 12.5'-14.5' schedule.

However, there may be other valid purposes outside the purview of the Special Project which would be served by the creation of a managed water retention area on this portion of the Rotenberger Tract. The substantial information contained in this report concerning the "Rotenberger Reservoir" should be useful in the future evaluation of other public needs in relation to that area. Accordingly, this information should be made available by the Special Project to other state agencies having an interest in those matters.

It is recommended that the construction of a water retention/recycling facility on the Rotenberger Tract west of the Miami Canal not be implemented as an undertaking of the Special Project in the Everglades Agricultural Area, since it does not satisfy the stated objectives of the Special Project.

Conservation Area No. 3A

A detailed analysis and evaluation of the northern portion of Conservation Area No. 3A as an alternative water retention/water recycling site was not made during the course of this investigation. It was believed that sufficient information would fall out from the detailed analysis and evaluation of the Holey Land site to permit a preliminary assessment of a site in the conservation area to be made. A more detailed analysis will require certain site-specific information; in particular topographic data and sub-surface information sufficient for determination of seepage characteristics. However, the site-specific data obtained on the Holey Land site can reasonably be extended to the adjacent conservation area, as modified by other available information.

There will be large volumes of flow available at S-7 and S-8 (flows generated from the S-7 and S-8 drainage areas plus re-directed flows from the Lake). But, as noted in this report, the alternative retention area system should be operated to ensure within reasonable limits that historical flows into the conservation areas are maintained. Those flows should neither be significantly diminished nor materially augmented by runoff waters originating in the Everglades Agricultural Area. Therefore, even though there are large volumes of water available and large amounts of land in the northern portion of Conservation Area No. 3A on which to store it, much of that land is superfluous because not all of the runoff water which will arrive at S-7 and S-8 can be made available for storage in the alternative retention site. All of this water cannot be placed in storage in the upper end of Conservation Area No. 3A, since by doing so, the remainder of the conservation area system downstream would be deprived of water it would otherwise receive.

The constraint of reasonably maintaining historical flows to the conservation areas, together with the other ecological constraints of a 3.0 ft. to 4.0 ft. maximum regulated water depth and a maximum June stage rise of 1.0 ft. in the retention area, will be applicable to a retention site in Conservation Area No. 3A. Analysis of the Holey Land Reservoir operating under those constraints has indicated that a retention area of 30,000-35,000 acres is about optimal with respect to both filling performance and recycling capability. Consequently, an optimum retention/recycling site in Conservation Area No. 3A would be of similar size.

With a conservation area retention site having approximately the same surface area and regular configuration as the Holey Land Reservoir it is our opinion that the cost of constructing the facilities needed to create a sub-impoundment in Conservation Area No. 3A will also be approximately the same. The allocation of costs to various elements of the retention area might possibly change. For example: pumping station costs may decrease, but the cost of intake works, discharge facilities and irrigation water recycling facilities will increase. A preliminary assessment indicates, however, that total first costs for construction will not differ greatly from those calculated for a comparable retention site (Holey Land Reservoir) within the Everglades Agricultural Area.

From an ecological standpoint it is the District's view that an alternative retention/recycling area in the northern portion of Conservation Area No. 3A is not acceptable. The basis for this view is presented on pages 48 and 49 of this report.

The District has previously expressed its position in regard to the creation of a sub-impoundment area in the northern portion of Conservation Area No. 3A. This area was considered by the Corps of Engineers as a location for creation of additional storage during the investigations which resulted in the "Water Resources Plan" (1968) for the C&SF Project. In a letter dated August 23, 1967, to the Jacksonville District Engineer, signed by the Executive Director, the following position was stated:

> "We object to the imposition of a regimen of higher water elevations in the Pool 3C portion of Conservation Area No. 3."

"Pool 3C" was the designation given to that portion of Conservation Area No. 3A lying north of Alligator Alley. The "regimen of higher water elevations" produced a maximum water depth of 4.0 ft. in the proposed sub-impoundment.

The position of the District with regard to the creation of a sub-impoundment area, or areas, in the northern portion of Conservation Area No. 3A, as expressed in the referenced letter, has not changed.

Pertinent Data for Recommended Plan

1. The average annual volume of runoff which will be directed away from Lake Okeechobee is an estimated 203,910 A.F., a 94% reduction in the volume now being discharged to the Lake at S-2 and S-3 from the Miami and North New River Canal basins.

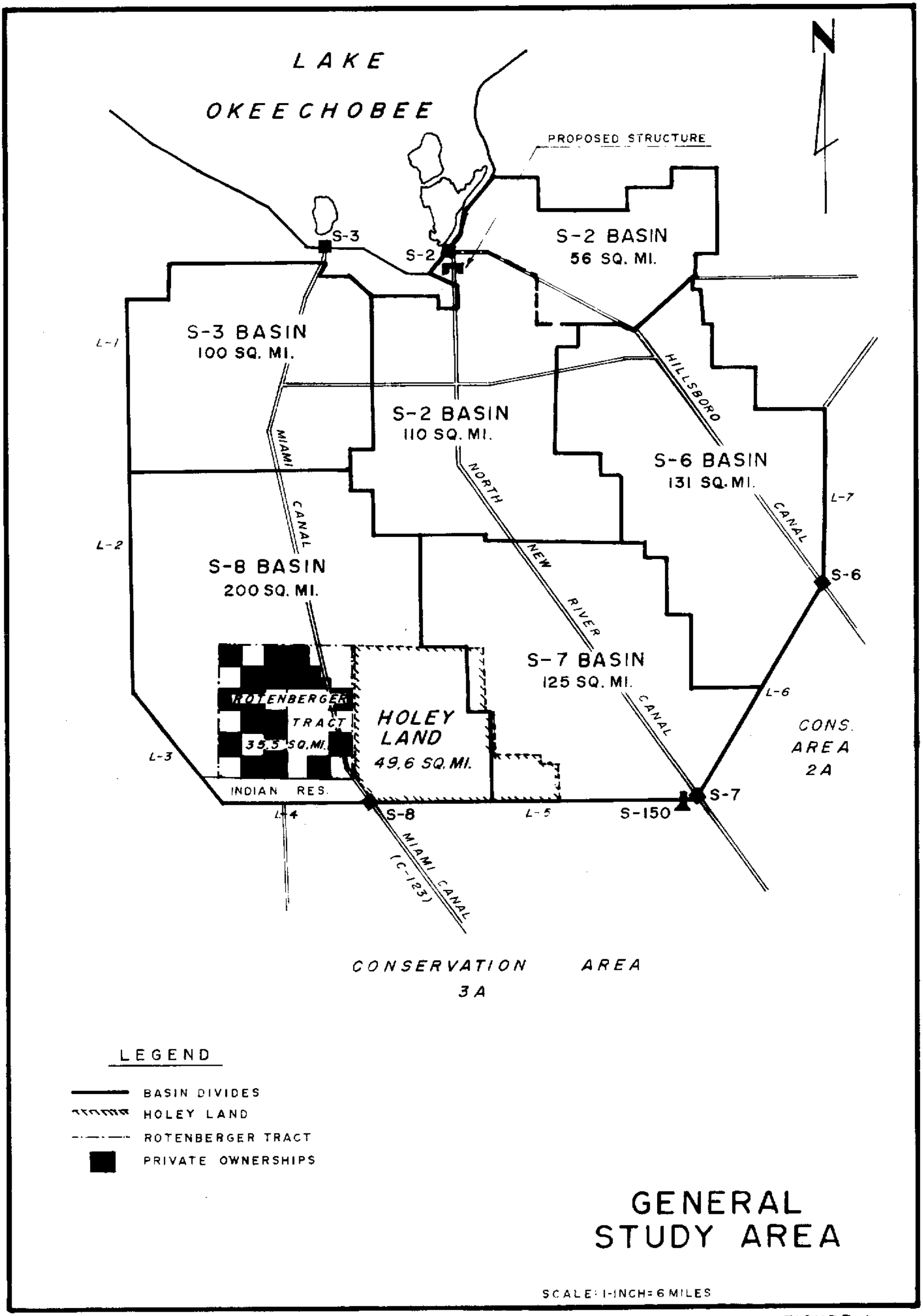
2. An estimated average volume of 84,700 A.F. will be recycled into the Miami and North New River Canals to meet irrigation requirements in the service areas of those canals; a supply which represents an estimated 47% of the average annual irrigation water requirement of those basins.

3. The estimated first costs, exclusive of acquisition costs of reservoir lands, are:

(a)	Retention area		\$ 6,762,000
(b)	Fish concentration canals		540,000
		Sub-Total	\$ 7,302,000
(c)	Flow re-direction		7,195,000*
		Total	\$14,497,000

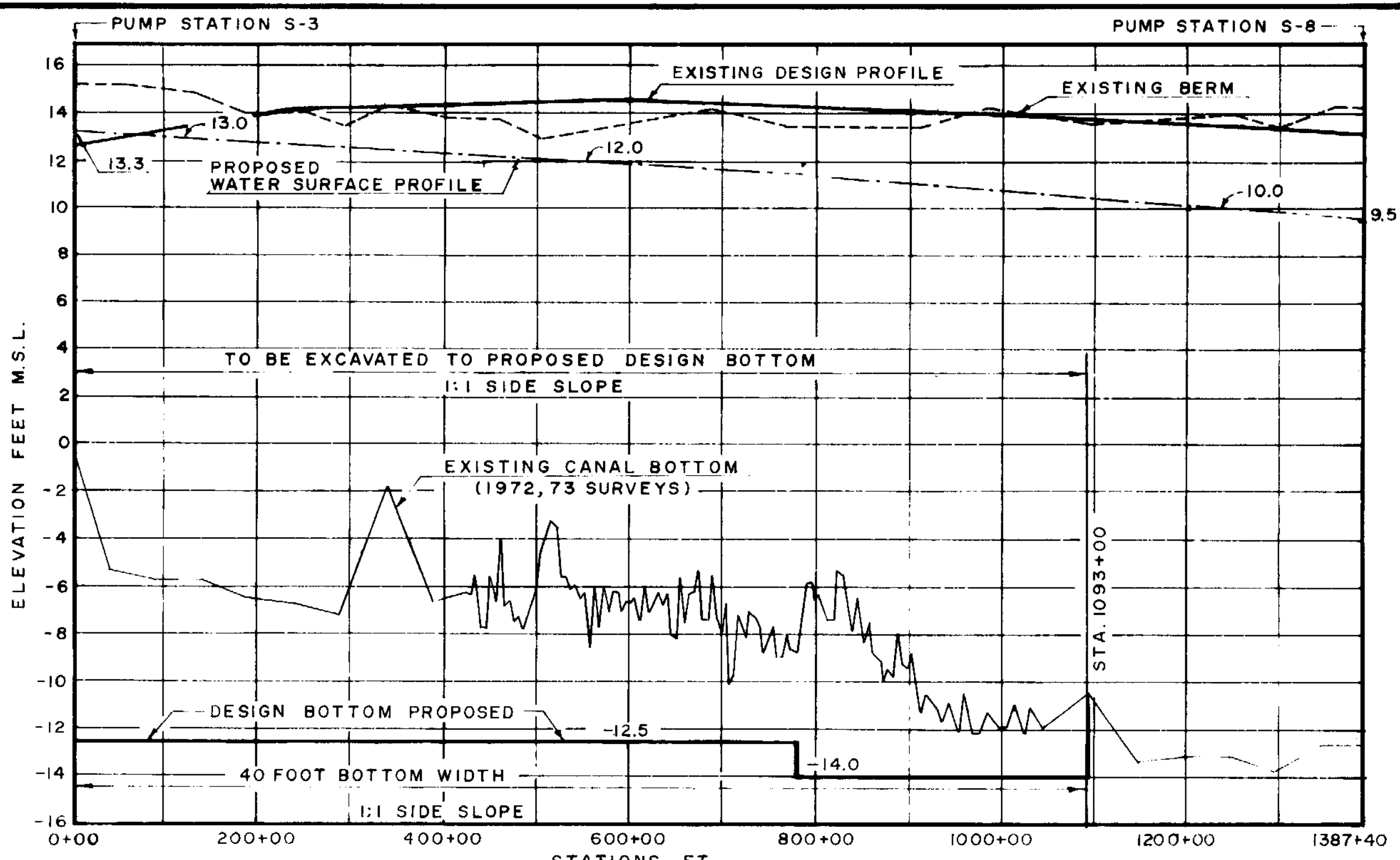
*These costs to be borne by the Central and Southern Florida Project.

4. The estimated annual costs assignable to the recommended plan, based on a 5 7/8% interest rate, 30-year life, and exclusive of reservoir land acquisition costs, are \$620,000.



LAKE
OKEECHOBEE
PROPOSED STRUCTURE
S-3
S-2
S-2 BASIN
56 SQ. MI.
S-3 BASIN
100 SQ. MI.
L-1
HILLSBORO
S-2 BASIN
110 SQ. MI.
MIAMI
CANAL
S-6 BASIN
131 SQ. MI.
NORTH
NEW
RIVER
CANAL
L-7
CANAL
L-2
S-8 BASIN
200 SQ. MI.
S-6
S-7 BASIN
125 SQ. MI.
ROTENBERGER
TRACT
35.5 SQ. MI.
HOLEY
LAND
49.6 SQ. MI.
L-6
CONS.
AREA
2A
L-3
INDIAN RES.
L-4
S-8
L-5
S-150
S-7
MIAMI CANAL
(C-123)
CONSERVATION AREA
3A
LEGEND
BASIN DIVIDES
HOLEY LAND
ROTENBERGER TRACT
PRIVATE OWNERSHIPS
GENERAL
STUDY AREA
SCALE: 1-INCH=6 MILES

FIGURE 1

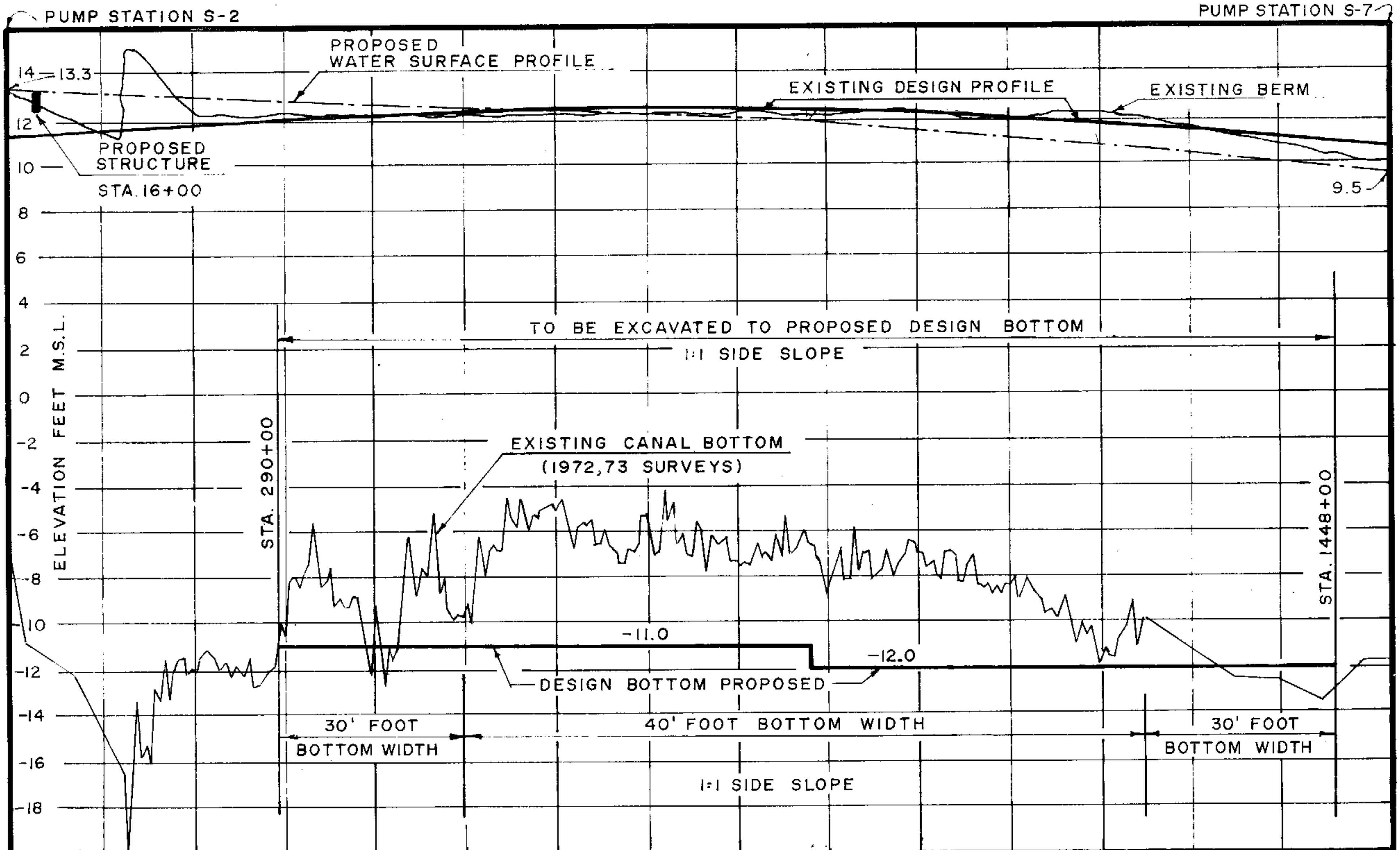


MIAMI CANAL

HUMP REMOVAL AND WATER SURFACE PROFILES

FIGURE 2

FIGURE 2



NORTH NEW RIVER CANAL
HUMP REMOVAL AND
WATER SURFACE PROFILES
FIGURE 3

FIGURE 3

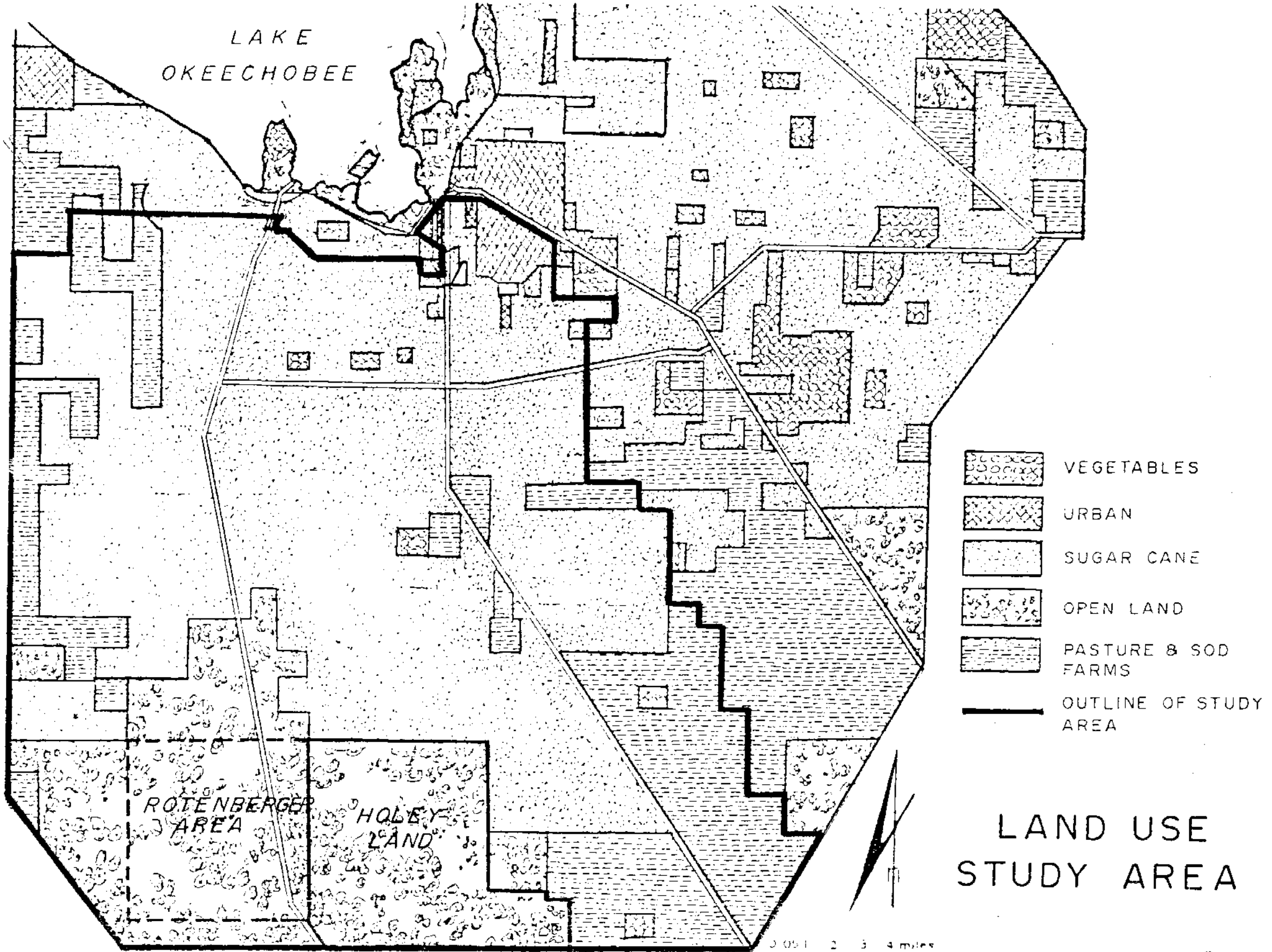
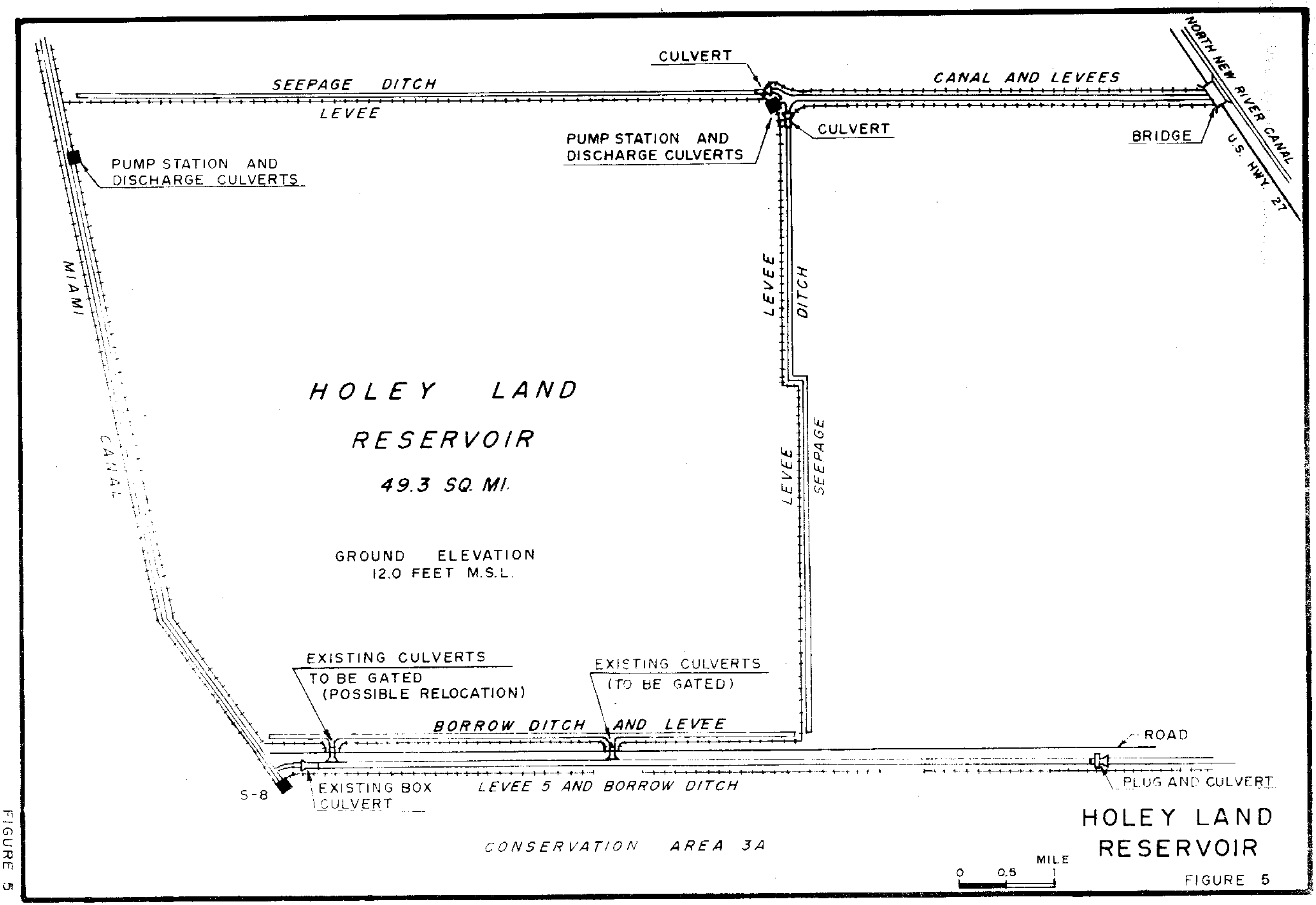


FIGURE 4

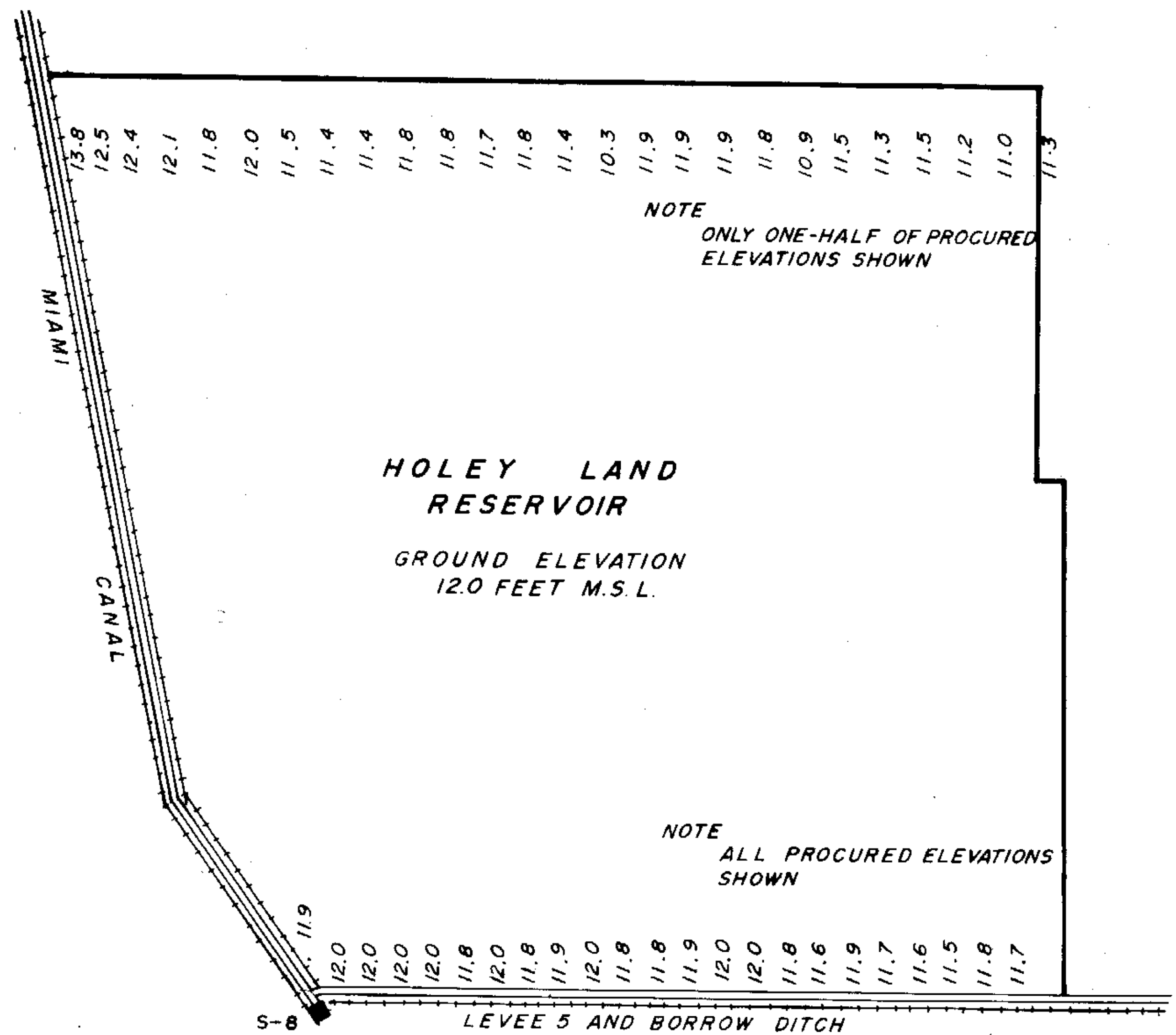
FIGURE 4



HOLEY LAND RESERVOIR

FIGURE 5

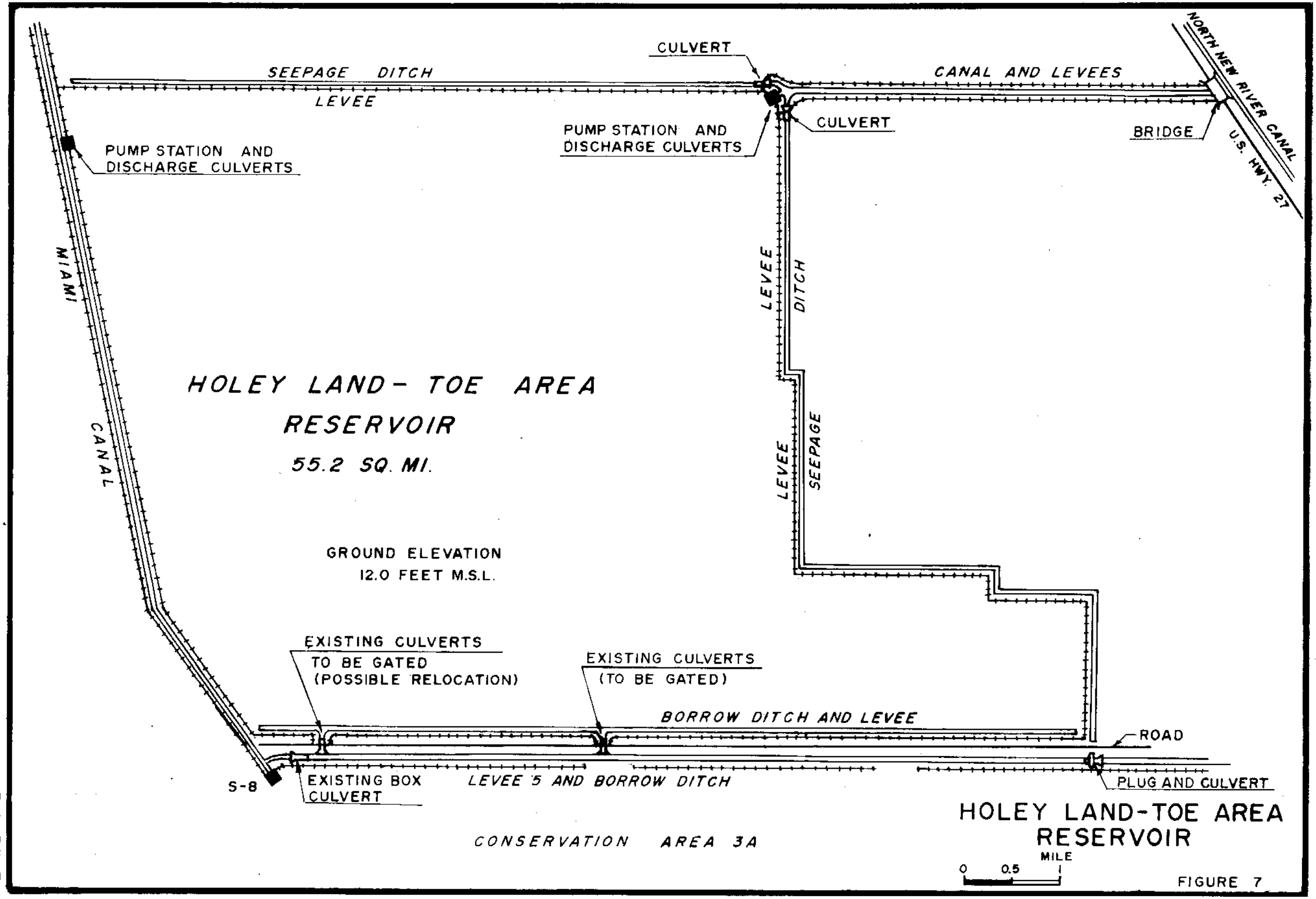
FIGURE 5



GROUND ELEVATIONS
HOLEY LAND

FIGURE 6

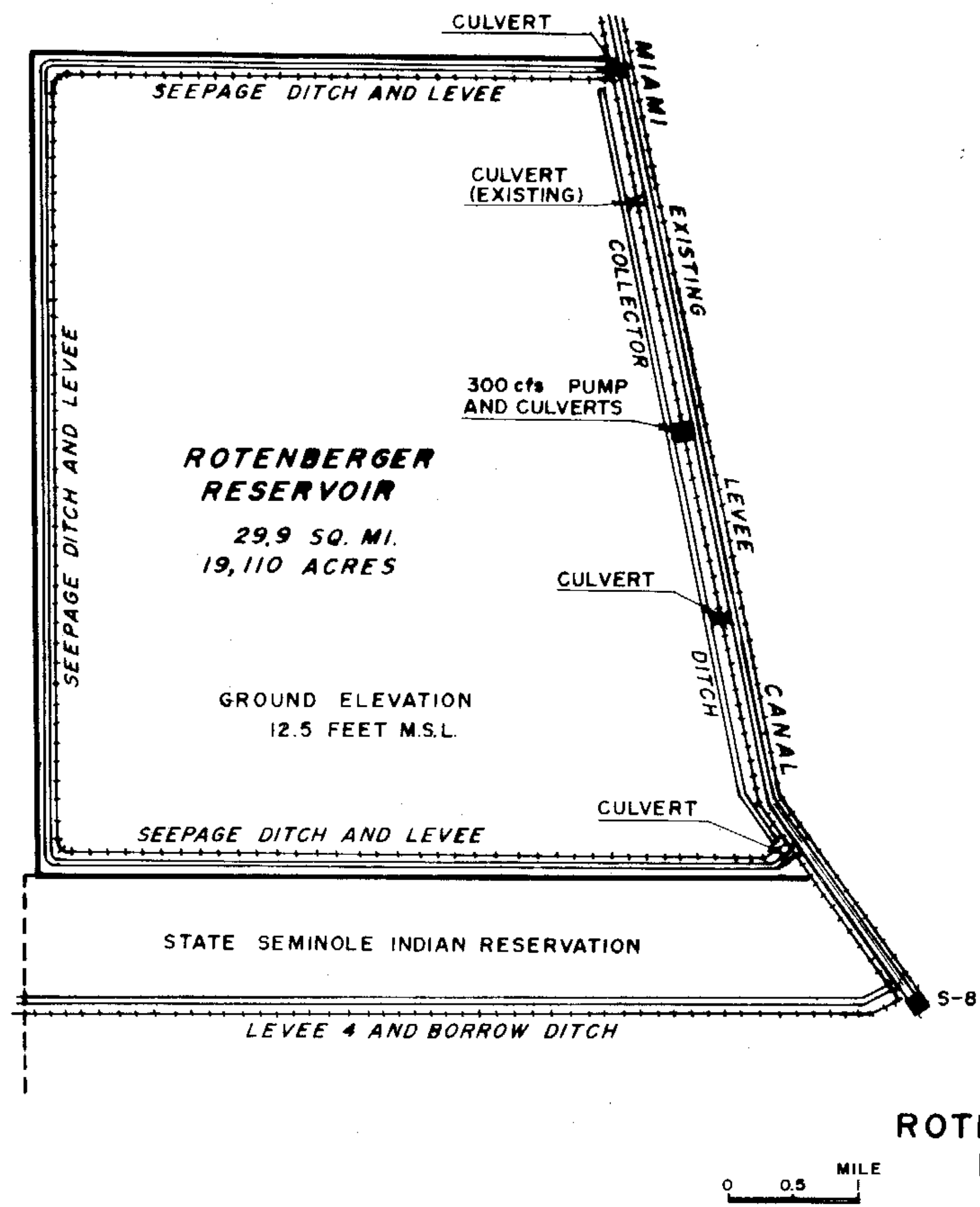
FIGURE 6



HOLEY LAND-TOE AREA
RESERVOIR

FIGURE 7

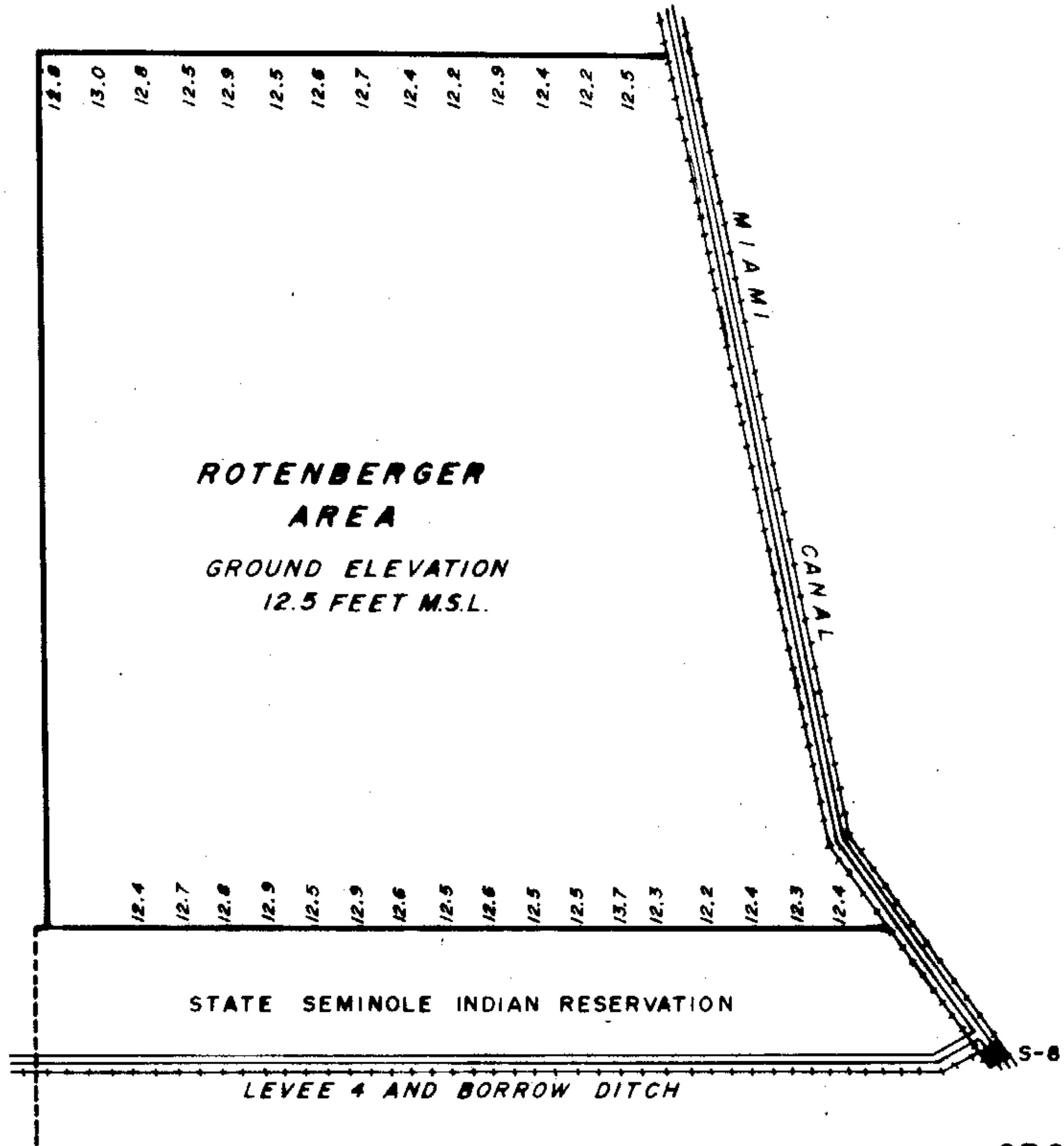
FIGURE 7



ROTENBERGER AREA
RESERVOIR

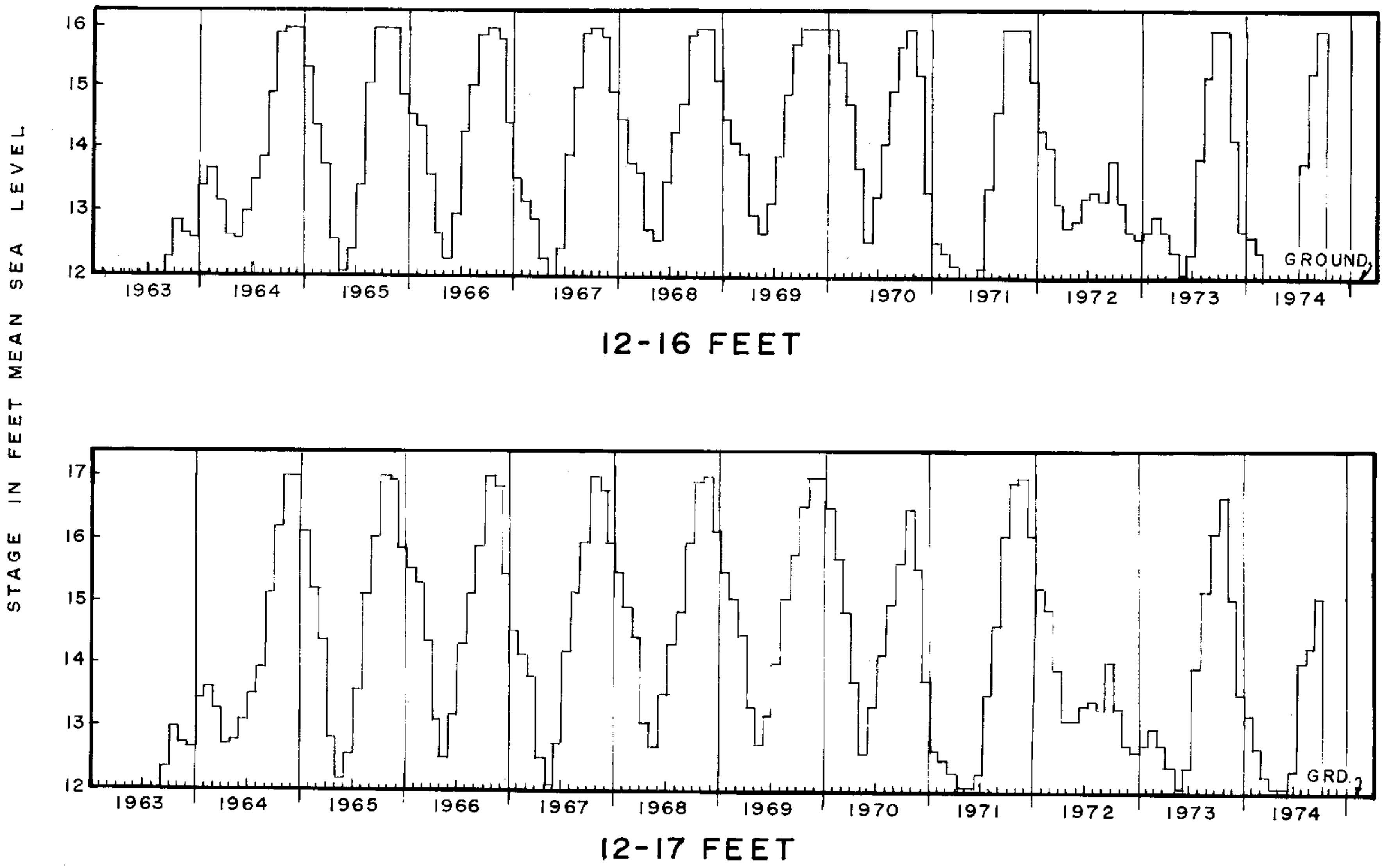
FIGURE 8

FIGURE 8



GROUND ELEVATIONS
ROTENBERGER AREA

FIGURE 9

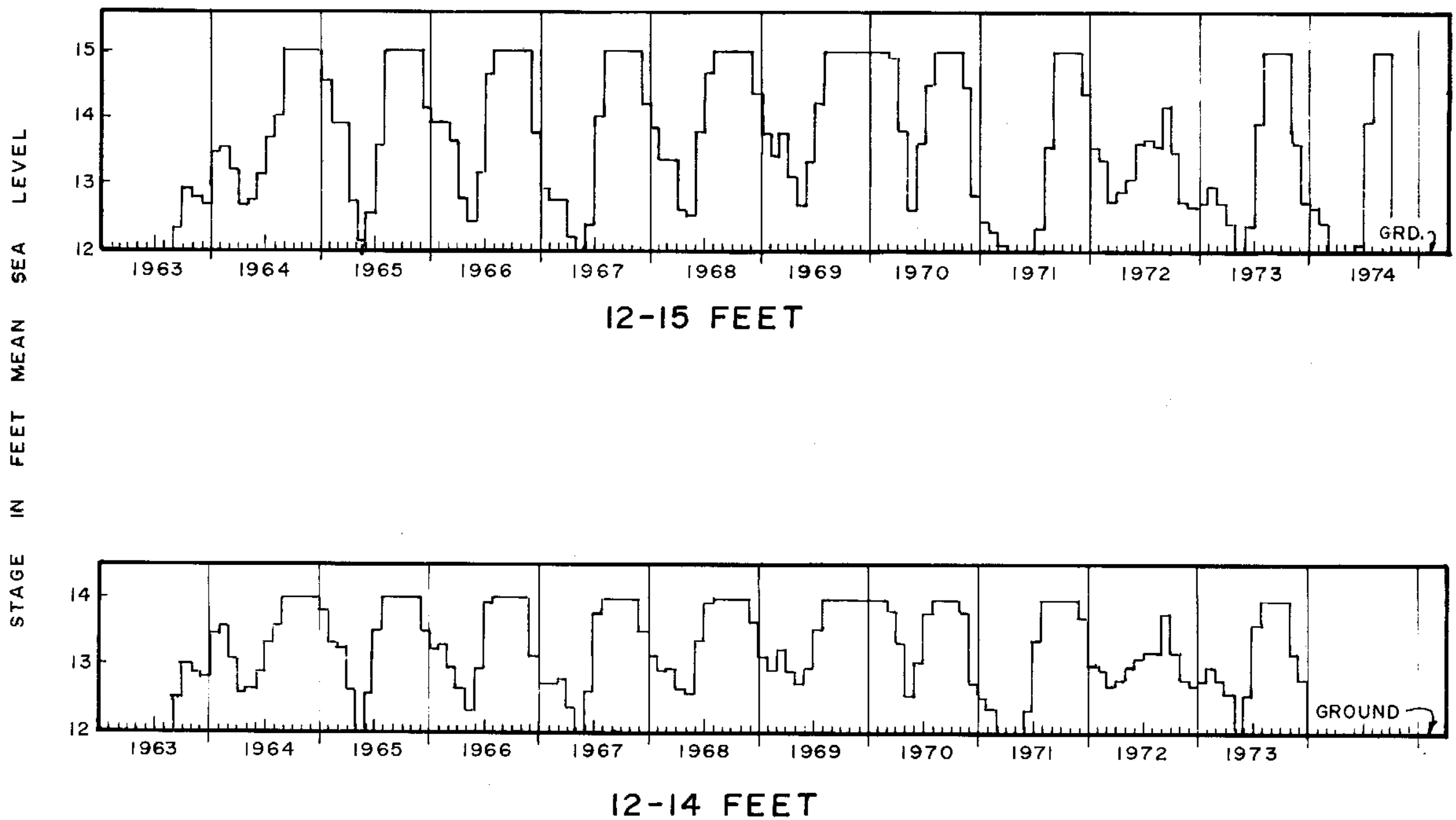


NOTE
STAGES ARE AVERAGE MONTHLY

STAGE REGULATIONS
HOLEY LAND RESERVOIR

FIGURE 10A

FIGURE 10A

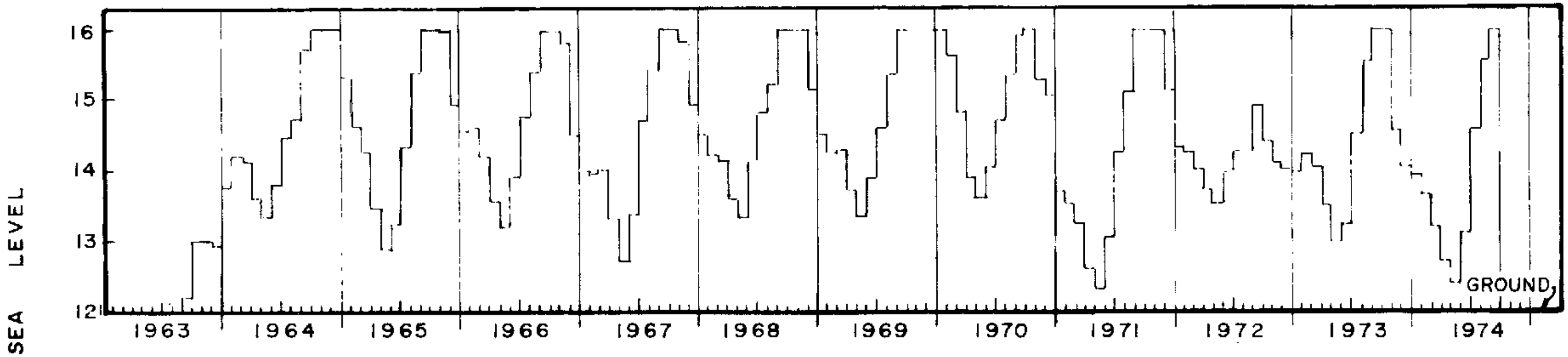


NOTE
STAGES ARE AVERAGE MONTHLY

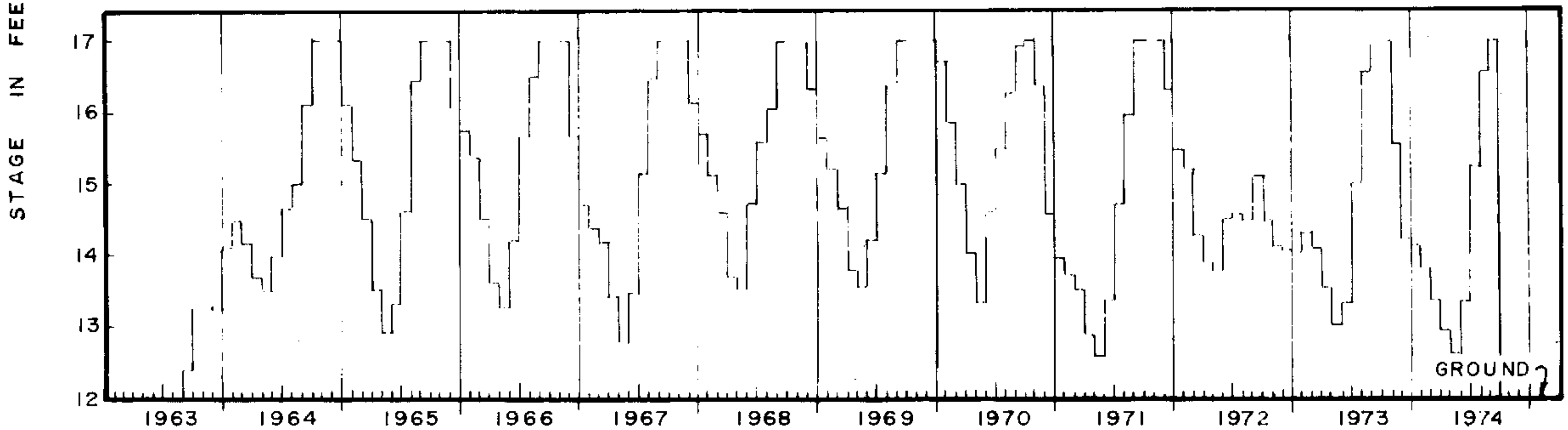
STAGE REGULATION
HOLEY LAND RESERVOIR

FIGURE 10B

FIGURE 10B



13-16 FEET



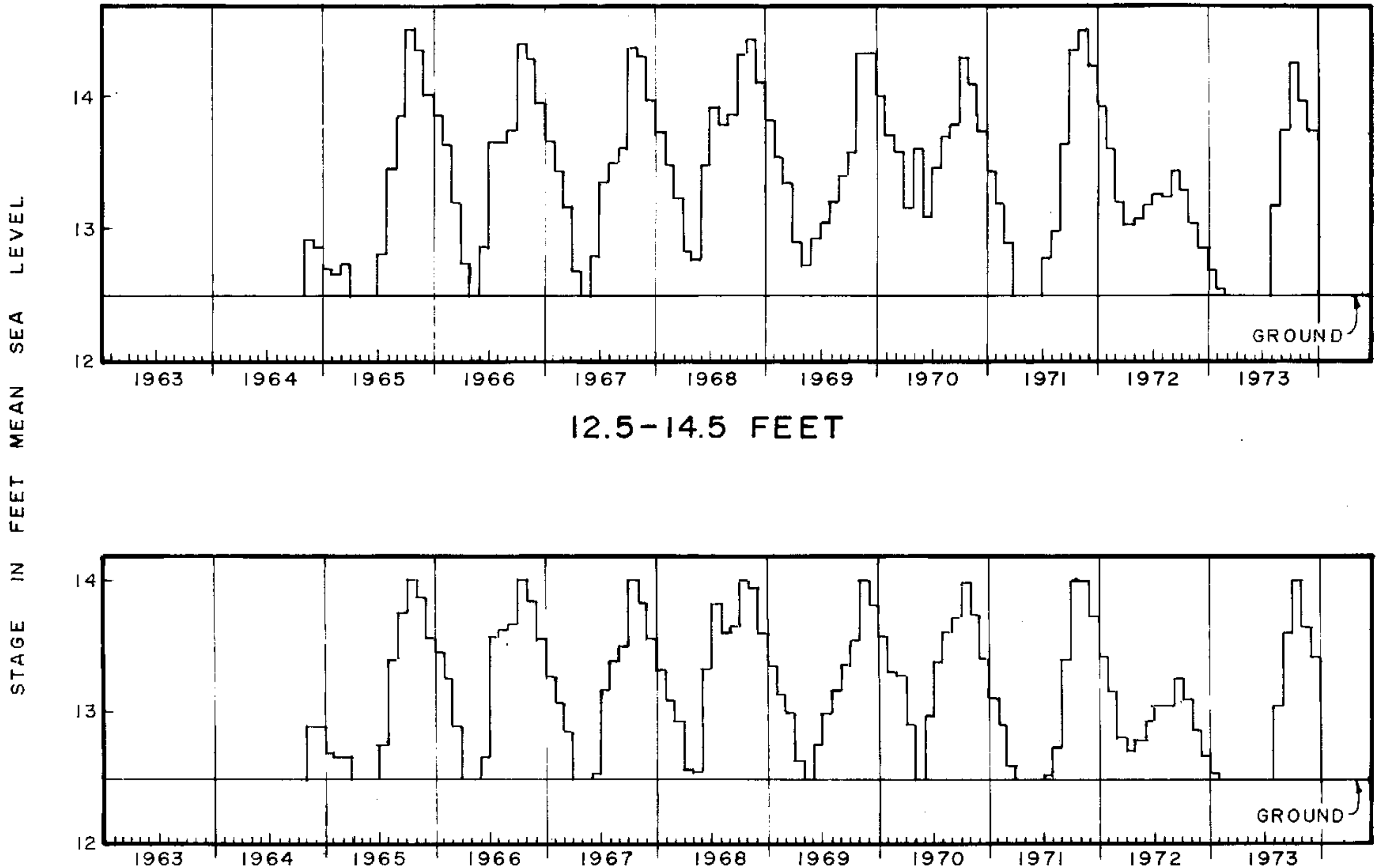
13-17 FEET

NOTE
STAGES ARE AVERAGE MONTHLY

STAGE REGULATIONS
HOLEY LAND RESERVOIR

FIGURE 10C

FIGURE 10C



12.5-14.5 FEET

12.5-14.0 FEET

NOTE
STAGES ARE AVERAGE MONTHLY

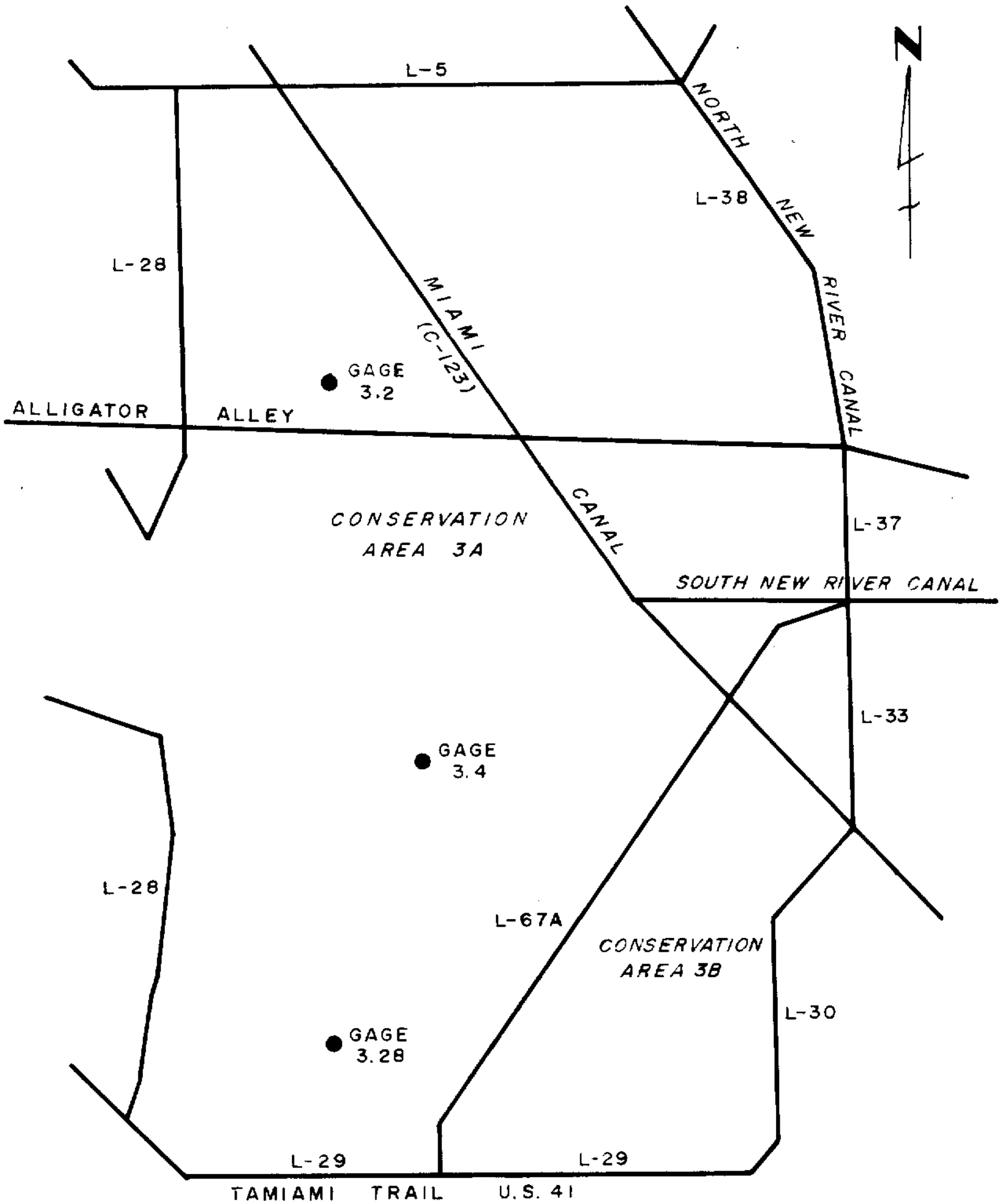
STAGE REGULATIONS
ROTENBERGER RESERVOIR

FIGURE 11

FIGURE 12 MATRIX OUTLINING RELATIVE EFFECTS OF VARIOUS WATER REGULATION SCHEDULES ON FISH, VEGETATION AND WILDLIFE IN THE HOLEY LAND

WATER SCHEDULE	WET PRAIRIES		HEALTHY SAWGRASS		HUNTABLE DEER HERD		EVERGLADE KITES		DUCK HUNTING		WADING BIRDS		SPORT FISHING WITH ENGINEERING DESIGN FOR HOLEY LAND PROJECT		SPORT FISHING W/ ARTIFICIAL DEEP WATER HABITAT AVAIL-ABLE (DEAD END CANALS, ROCKPITS, ETC.)		WATER QUALITY BENEFITS	
(ft. msl)	YES	NO	YES	NO	YES	NO	RESIDENT	TRANSITORY	YES	NO	ABUNDANT	LIMITED	EXCELLENT	LIMITED	EXCELLENT	LIMITED	HIGH	LOW
14 – 12	X		X		?			X	X		X			X	X		X	
15 – 12	X		X			X		X	X		X			X	X		X	
16 – 12	X		X			X		X	X		X			X	X		X	
16 – 13		X	X			X	X		X			X	X		X		X	
17 – 12		X	?			X		X	X		X			X	X			X
17 – 13		X	?			X	X		X			X	X		X			X

FIGURE 12



MAP OF CONSERVATION AREA 3
WITH LOCATIONS OF WATER GAGES

FIGURE 13

RAINFALL AT S-8 IN INCHES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1963	1.61	4.16	0.17	1.38	4.32	4.14	0.31	5.60	7.19	1.70	2.81	5.05	38.44
1964	1.35	2.59	3.40	4.71	4.89	10.34	8.46	6.59	5.79	7.14	0.92	2.38	58.56
1965	0.10	2.79	0.39	0.90	1.92	5.88	11.54	8.19	7.76	5.88	0.25	0.80	46.40
1966	3.95	0.83	0.14	1.49	4.13	19.84	6.46	3.43	5.68	6.05	0.07	0.78	52.85
1967	0.60	2.89	0.43	0	2.24	13.35	10.60	3.77	8.57	4.21	0.26	1.61	48.53
1968	0.45	2.52	1.12	0.69	10.38	14.87	9.62	3.67	4.69	6.14	1.04	0.20	55.39
1969	1.47	2.01	2.99	2.71	4.71	9.00	5.91	4.67	4.67	9.88	1.44	1.80	51.26
1970	1.80	2.61	10.53	0	9.64	8.32	10.37	7.29	5.52	3.62	0.16	0.78	60.64
1971	0.53	2.64	0.60	0.08	4.47	7.05	4.59	4.98	5.60	6.87	3.70	1.72	42.83
1972	0.48	1.85	5.95	5.98	5.67	8.29	6.25	3.71	5.27	0.85	2.25	1.78	48.33
1973	2.57	0.76	3.93	0.31	3.66	4.76	10.36	6.33	8.90	3.63	0.06	1.75	47.02
Average	1.36	2.33	2.70	1.66	5.09	9.62	7.68	5.29	6.33	5.09	1.16	1.70	50.02

TABLE 1

CLASS "A" PAN EVAPORATION AT S-7 IN INCHES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1963	2.48	2.51	5.38	6.35	4.93	4.47	5.48	4.22	2.61	3.80	2.65	2.12	47.00
1964	2.08	3.14	4.29	5.52	5.17	3.52	4.58	3.96	3.61	2.97	2.83	2.47	44.14
1965	3.02	3.10	5.38	6.06	6.87	3.13	3.52	4.04	3.13	3.25	3.34	2.86	47.70
1966	1.99	2.94	4.53	5.37	5.13	2.91	3.70	4.16	2.69	2.69	3.19	2.46	41.76
1967	2.67	2.90	4.93	6.27	6.69	2.17	4.41	2.75	3.24	2.91	3.01	2.55	44.50
1968	2.68	2.86	4.77	5.31	3.84	2.79	5.03	4.26	2.97	3.39	3.14	2.95	43.99
1969	2.39	3.43	3.35	5.21	4.17	3.27	4.03	3.93	4.14	3.59	3.40	2.87	43.78
1970	2.76	3.09	4.11	6.45	5.49	4.31	3.38	5.73	4.25	3.72	4.05	3.46	50.80
1971	3.40	3.59	6.36	7.20	7.12	3.42	4.06	4.42	3.01	2.71	2.75	3.27	51.31
1972	2.88	3.56	5.44	5.59	4.22	3.80	4.79	4.28	4.10	3.27	2.74	3.18	47.85
1973	3.15	3.48	5.49	7.09	6.34	4.70	3.17	3.03	3.81	3.62	3.56	2.91	50.35
Average	2.68	3.15	4.91	6.04	5.45	3.50	4.20	4.07	3.41	3.27	3.15	2.83	46.65

RUNOFF FROM NORTH NEW RIVER CANAL CFS-DAYS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1962	2	0	3136	2415	194	11,411	13,085	10,258	30,794	14,465	1563	0	87,323
1963	170	4439	0	0	6542	819	0	2006	8315	2842	1519	2779	29,431
1964	8388	1857	491	3396	1528	6848	6389	9455	7229	21,559	4498	5823	77,461
1965	0	4787	3389	0	0	12,597	18,484	12,061	11,634	13,405	1377	0	77,734
1966	5072	5995	785	1977	3304	29,442	45,938	19,737	23,785	21,969	1725	1998	161,727
1967	844	8577	1678	0	0	15,031	19,017	20,327	17,984	28,666	1335	5317	118,776
1968	1216	4575	2335	0	15,713	47,321	33,639	8662	30,449	24,359	1558	0	169,827
1969	6288	4231	11,402	3762	6294	27,616	13,949	19,915	21,639	18,739	13,488	5840	153,163
1970	12,823	12,520	47,736	1529	16,841	24,034	21,582	10,808	5909	2603	29	0	156,414
1971	510	1968	304	0	4242	27,684	24,630	18,408	39,426	25,559	11,119	1590	155,440
1972	2307	3021	2371	14,764	42,515	29,121	8194	5816	4862	803	3025	1019	117,818
1973	5013	2420	2917	0	2193	10,152	41,404	33,558	10,202	4671	0	3141	115,671
AVE	3553	4533	6379	2320	8281	20,173	20,526	14,251	17,686	14,970	3436	2425	118,399

IRRIGATION DEMAND NORTH NEW RIVER CANAL CFS-DAYS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1962	2831	3737	5656	3063	6783	2260	336	82	94	1919	1145	5710	33,616
1963	4958	2009	6642	14,562	4532	4297	11,316	7654	3822	5397	3513	4503	73,205
1964	2662	3465	6030	6640	6523	3644	1629	1457	414	1977	3464	2865	40,770
1965	6907	4480	6969	14,872	20,414	5323	2265	1624	961	1623	3801	11,815	81,054
1966	4382	4322	5172	8032	6512	761	0	1493	428	15	8972	7457	47,550
1967	4157	987	6400	19,368	20,633	3728	26	0	0	0	7705	3718	66,722
1968	2446	1777	1543	8747	4255	0	727	750	907	946	4664	10,025	36,787
1969	1480	4465	2803	9213	2191	1189	2115	1336	700	2504	1071	1586	30,653
1970	366	187	321	7366	15,694	0	114	371	646	4058	12,041	14,339	55,503
1971	9807	4832	11,534	16,966	7770	2900	0	708	0	2206	4742	7080	68,545
1972	5481	4942	10,078	6579	0	368	2700	3150	2014	13,691	5951	5320	60,274
1973	2158	1564	6486	15,120	13,421	2648	0	32	420	5499	23,251	7383	77,982
AVE	3970	3064	5803	10,877	9061	2260	1769	1555	867	3320	6693	6817	56,055

TABLE 3

TABLE 4

RUNOFF FROM MIAMI CANAL CFS-DAYS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	1,039	216	772	1,029	200	7,514	14,453	10,766	28,769	14,985	186	61	79,990
1963	59	3,968	86	0	9,016	3,840	469	2,186	6,310	3,621	1,336	2,655	33,546
1964	10,091	6,245	777	2,175	498	4,511	2,386	5,554	13,125	21,537	5,363	5,717	77,979
1965	150	6,651	5,744	0	0	14,104	14,675	10,104	18,476	24,142	1,894	1,015	96,955
1966	8,457	4,117	3,315	1,698	2,403	14,853	32,636	24,236	12,566	9,946	109	209	114,545
1967	360	2,172	0	0	422	20,563	19,874	16,665	11,848	24,634	556	1,982	99,076
1968	0	3,905	806	0	6,976	42,258	42,930	11,435	19,026	23,688	7,417	0	158,438
1969	2,757	1,462	9,904	203	719	23,379	11,773	21,612	5,293	18,528	11,489	7,975	115,094
1970	6,790	4,123	48,845	6,896	9,451	13,911	19,376	19,059	13,076	9,015	85	0	150,627
1971	365	283	0	0	4,182	15,573	15,304	9,796	34,542	26,911	10,048	572	117,576
1972	749	2,826	998	5,132	18,275	23,067	2,803	5,441	4,738	866	1,017	186	66,098
1973	4,905	808	1,448	0	547	5,891	17,889	22,689	18,173	4,407	0	2,289	79,046
Average	2,977	3,065	6,058	1,428	4,391	15,789	16,214	13,295	15,495	15,190	3,292	1,888	99,081

IRRIGATION DEMAND MIAMI CANAL CFS-DAYS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	1,559	1,566	2,516	2,699	4,381	1,565	0	689	0	0	0	1,614	16,589
1963	1,246	0	2,765	6,833	1,856	0	3,358	2,732	1,000	2,101	961	1,550	24,402
1964	633	2,053	2,557	4,263	4,844	1,308	752	1,918	0	0	808	73	19,209
1965	5,079	1,381	1,819	8,281	10,979	2,180	1,874	4	50	385	510	4,137	36,679
1966	136	1,540	4,251	7,522	6,677	2,433	0	0	0	0	3,219	6,953	32,731
1967	4,600	2,683	7,593	10,628	8,696	290	0	0	0	0	3,274	3,054	40,818
1968	4,164	2,818	1,832	8,338	1,821	0	0	0	0	0	1,301	5,253	25,527
1969	3,022	1,727	785	8,120	9.610	1,943	508	0	149	2,746	0	183	28,793
1970	1,422	2,055	1,141	4,216	9,047	0	0	0	0	1,364	8,968	6,270	34,483
1971	4,855	3,312	6,741	8,825	2,462	1,292	203	401	0	864	2,347	4,162	35,464
1972	3,528	1,949	5,027	1,721	280	212	1,062	5,700	1,375	6,762	2,646	1,953	32,215
1973	1,030	447	1,660	8,783	11,455	5,839	310	0	0	2,410	12,499	3,990	48,423
Average	2,606	1,794	3,224	6,686	6,009	1,422	672	954	215	1,386	3,044	3,266	31,278

IRRIGATION RELEASES ACRE FEET 12 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	14846.	8859.	853.	25049.
1964	6524.	10926.	17002.	2101.	1196.	6661.	4714.	6682.	820.	3914.	8354.	5817.	74711.
1965	23732.	11605.	17400.	16703.	0	1942.	8195.	3223.	2002.	3976.	8536.	31276.	128591.
1966	8946.	11607.	18620.	18737.	0	3643.	0	2956.	847.	30.	23623.	27819.	116828.
1967	17339.	7267.	28003.	7902.	0	404.	51.	0	0	0	21738.	13409.	96113.
1968	13088.	9098.	6682.	25502.	1012.	0	1439.	1485.	1796.	1873.	11811.	30250.	104037.
1969	8914.	12260.	7104.	24978.	313.	531.	5194.	2645.	1681.	10056.	2121.	3503.	79299.
1970	3540.	4439.	2895.	17812.	0	0	226.	735.	1279.	10736.	41251.	40806.	123718.
1971	13058.	0	0	0	0	855.	401.	2196.	0	4955.	13460.	22259.	57185.
1972	17838.	13644.	28944.	11054.	554.	1148.	7449.	17523.	6710.	39476.	898.	0	145239.
1973	865.	3981.	3262.	245.	0	1946.	614.	63.	832.	13628.	59576.	19929.	104942.
AVE.	10349.	7712.	11810.	11367.	280.	1557.	2571.	3410.	1496.	9408.	18202.	17811.	95974.

IRRIGATION RELEASES ACRE FEET 12 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	14177.	3093.	0	17761.
1964	6524.	10926.	17002.	786.	974.	6661.	4714.	6682.	820.	3914.	8354.	5817.	73175.
1965	23732.	11605.	17400.	18794.	0	1942.	8195.	3223.	2002.	3976.	8536.	31276.	130681.
1966	8946.	11607.	18620.	18737.	0	3643.	0	2956.	847.	30.	23623.	27819.	116828.
1967	17339.	7267.	28003.	9435.	0	404.	51.	0	0	0	21738.	13409.	97646.
1968	13088.	9098.	6683.	27712.	1012.	0	1439.	1485.	1796.	1873.	11811.	30250.	106247.
1969	8914.	12260.	7104.	28409.	313.	531.	5194.	2645.	1681.	10056.	2121.	3503.	82730.
1970	3540.	4439.	2895.	19238.	0	0	226.	735.	1279.	10736.	41251.	40806.	125144.
1971	17436.	0	0	0	0	855.	401.	2196.	0	4955.	13460.	22259.	61563.
1972	17838.	13644.	28944.	12670.	554.	1148.	7449.	17523.	6710.	39476.	898.	0	146854.
1973	865.	3981.	451.	19.	0	556.	614.	63.	832.	13628.	59576.	19929.	100514.
AVE.	10747.	7712.	11555.	12345.	259.	1431.	2571.	3410.	1496.	9347.	17678.	17733.	96286.

12 - 17 REGULATION
TABLE 5

IRRIGATION RELEASES ACRE FEET 12 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	14846.	8859.	0	24196.
1964	6524.	10926.	17002.	786.	1196.	6661.	4714.	6682.	820.	3914.	8354.	5817.	73397.
1965	23732.	11605.	17400.	14991.	0	1942.	8195.	3223.	2002.	3976.	8536.	31276.	126878.
1966	8946.	11607.	18620.	18737.	0	3643.	0	2956.	847.	30.	23623.	27819.	116828.
1967	17339.	7267.	17444.	0	0	404.	51.	0	0	0	21738.	13409.	77652.
1968	13088.	9098.	6682.	22562.	321.	0	1439.	1485.	1796.	1873.	11811.	30250.	100406.
1969	8914.	12260.	7104.	24291.	313.	531.	5194.	2645.	1681.	10056.	2121.	3503.	78612.
1970	3540.	4439.	2895.	17812.	0	0	226.	735.	1279.	10736.	41251.	40806.	123718.
1971	1451.	0	0	0	0	655.	401.	2196.	0	4955.	13460.	22259.	45578.
1972	17838.	13644.	23653.	11054.	554.	1148.	7449.	17523.	6710.	35811.	898.	0	136283.
1973	865.	3981.	2599.	245.	0	1194.	614.	63.	832.	13628.	59576.	19929.	103526.
AVE.	9294.	7712.	10309.	10043.	217.	1489.	2571.	3410.	1496.	9075.	18202.	17733.	91552.

IRRIGATION RELEASES ACRE FEET 12 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	12092.	2928.	0	15511.
1964	6524.	10926.	16604.	0	758.	6661.	4714.	6682.	820.	3914.	8354.	5817.	71775.
1965	23732.	11605.	17400.	16703.	0	1942.	8195.	3223.	2002.	3976.	8536.	31276.	128591.
1966	8946.	11607.	18620.	18737.	0	3643.	0	2956.	847.	30.	23623.	27819.	116828.
1967	17339.	7267.	22724.	0	0	404.	51.	0	0	0	21738.	13409.	82932.
1968	13088.	9098.	6683.	25502.	321.	0	1439.	1485.	1796.	1873.	11811.	30250.	103346.
1969	8914.	12260.	7104.	27455.	313.	531.	5194.	2645.	1681.	10056.	2121.	3503.	81776.
1970	3540.	4439.	2895.	19238.	0	0	226.	735.	1279.	10736.	41251.	40806.	125144.
1971	6100.	0	0	0	0	655.	401.	2196.	0	4955.	13460.	22259.	50227.
1972	17838.	13644.	27148.	9520.	554.	1148.	7449.	17523.	6710.	35811.	898.	0	138243.
1973	865.	3338.	263.	0	0	556.	614.	63.	832.	13628.	59576.	19929.	99664.
AVE.	9717.	7655.	10858.	10650.	177.	1431.	2571.	3410.	1496.	8825.	17663.	17733.	92185.

12 - 16 REGULATION
TABLE 5A

IRRIGATION RELEASES ACRE FEET 12 - 15 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	14846.	6758.	0	22095.
1964	6524.	10926.	17002.	1148.	1196.	6661.	4714.	6682.	820.	3914.	8354.	5817.	73759.
1965	23732.	11605.	17400.	12165.	0	1942.	8195.	3223.	2002.	3976.	8536.	31276.	124052.
1966	8946.	11607.	18620.	8674.	0	3643.	0	2956.	847.	30.	23623.	27819.	106766.
1967	10815.	257.	7217.	0	0	404.	51.	0	0	0	21738.	13409.	53892.
1968	13088.	9098.	6682.	8870.	0	0	1439.	1485.	1796.	1873.	11811.	30250.	86393.
1969	8914.	12260.	7104.	17990.	46.	531.	5194.	2645.	1681.	10056.	2121.	3503.	72044.
1970	3540.	4439.	2895.	17812.	0	0	226.	735.	1279.	10736.	41251.	17440.	100352.
1971	0	0	0	0	0	855.	401.	2196.	0	4955.	13460.	22259.	44127.
1972	17838.	13644.	3477.	4039.	554.	1148.	7449.	17523.	6710.	35811.	898.	0	109092.
1973	865.	3981.	2599.	245.	0	1194.	614.	63.	832.	13628.	50680.	2061.	76762.
AVE.	8569.	7074.	7545.	6450.	163.	1489.	2571.	3410.	1496.	9075.	17203.	13985.	79030.

IRRIGATION RELEASES ACRE FEET 12 - 15 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	12092.	2928.	0	15511.
1964	6524.	10926.	16604.	0	758.	6661.	4714.	6682.	820.	3914.	8354.	5817.	71775.
1965	23732.	11605.	17400.	13541.	0	1942.	8195.	3223.	2002.	3976.	8536.	31276.	125428.
1966	8946.	11607.	18620.	11664.	0	3643.	0	2956.	847.	30.	23623.	27819.	109755.
1967	15252.	257.	7217.	0	0	404.	51.	0	0	0	21738.	13409.	58329.
1968	13088.	9098.	6683.	10450.	0	0	1439.	1485.	1796.	1873.	11811.	30250.	87973.
1969	8914.	12260.	7104.	19946.	46.	531.	5194.	2645.	1681.	10056.	2121.	3503.	73900.
1970	3540.	4439.	2895.	19238.	0	0	226.	735.	1279.	10736.	41251.	21808.	106146.
1971	0	0	0	0	0	0	401.	2196.	0	4955.	13460.	22259.	43271.
1972	17838.	13644.	7415.	3966.	554.	1148.	7449.	17523.	6710.	37656.	898.	0	114802.
1973	865.	2928.	103.	0	0	354.	614.	63.	832.	13628.	56060.	2061.	77508.
AVE.	8973.	6979.	7640.	7155.	123.	1335.	2571.	3410.	1496.	8992.	17344.	14382.	80400.

12 - 15 REGULATION
TABLE 5B

IRRIGATION RELEASES ACRE FEET 12 - 14 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	14846.	2928.	0	18266.
1964	6524.	10926.	16604.	0	0	2457.	4714.	6682.	820.	3914.	8354.	5817.	66813.
1965	23732.	11605.	9811.	0	0	1154.	4192.	3223.	2002.	3976.	8536.	27029.	95259.
1966	7878.	11607.	6900.	0	0	1861.	0	2956.	847.	30.	23623.	15149.	70852.
1967	0	257.	2608.	0	0	404.	51.	0	0	0	21738.	13409.	38467.
1968	5712.	198.	4649.	0	0	0	1439.	1485.	1796.	1873.	11811.	26225.	55189.
1969	4176.	4182.	6993.	6599.	0	531.	5194.	2645.	1681.	10056.	2121.	3503.	47680.
1970	3540.	4439.	2895.	9104.	0	0	226.	735.	1279.	10736.	34111.	0	67065.
1971	0	0	0	0	0	0	401.	2196.	0	4955.	13460.	22259.	43271.
1972	3714.	3105.	0	10.	554.	1148.	2451.	17523.	6710.	22367.	0	0	57583.
1973	865.	3207.	263.	19.	0	0	614.	63.	832.	13628.	27045.	0	46536.
AVE.	5104.	4502.	4611.	1430.	50.	687.	1753.	3410.	1496.	7853.	13975.	10308.	55180.

IRRIGATION RELEASES ACRE FEET 12 - 14 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	491.	9417.	1929.	0	11836.
1964	6524.	10926.	15230.	0	0	1798.	4714.	6682.	820.	3914.	8354.	5817.	64780.
1965	23732.	11605.	11003.	0	0	470.	4192.	3223.	2002.	3976.	8536.	29124.	97811.
1966	7878.	11607.	6108.	0	0	1861.	0	2956.	847.	30.	23623.	18236.	73147.
1967	0	257.	1936.	0	0	404.	51.	0	0	0	21738.	13409.	37796.
1968	6623.	198.	4142.	0	0	0	1439.	1485.	1796.	1873.	11811.	28991.	58359.
1969	4176.	3429.	6461.	5227.	0	531.	5194.	2645.	1681.	10056.	2121.	3503.	45023.
1970	3540.	4430.	2895.	11021.	0	0	226.	735.	1279.	10736.	36185.	0	71054.
1971	0	0	0	0	0	0	401.	2196.	0	4955.	13460.	22259.	43271.
1972	6180.	3105.	0	0	554.	1148.	2451.	17523.	6710.	22367.	0	0	60038.
1973	865.	1603.	69.	0	0	0	614.	63.	832.	13628.	29106.	0	46780.
AVE.	5411.	4288.	4350.	1477.	50.	560.	1753.	3410.	1496.	7359.	14260.	11031.	55445.

12 - 14 REGULATION
TABLE 5C

IRRIGATION RELEASES ACRE FEET 13 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	5792.	10926.	1000.	0	0	0	3362.	6682.	820.	3914.	8354.	5817.	46667.
1965	23732.	11605.	2016.	0	0	0	0	3223.	2002.	3976.	8536.	31276.	86365.
1966	8946.	11607.	4227.	0	0	0	0	2956.	847.	30.	23623.	27819.	80055.
1967	17339.	1725.	2245.	0	0	0	16.	0	0	0	21738.	13409.	56472.
1968	13088.	9098.	3247.	0	0	0	1439.	1485.	1796.	1873.	11811.	30250.	74088.
1969	8914.	12260.	3960.	0	0	0	5194.	2645.	1681.	10056.	2121.	3503.	50334.
1970	3540.	4439.	2895.	0	0	0	226.	735.	1279.	10736.	41251.	26589.	91690.
1971	0	0	0	0	0	0	401.	2196.	0	4955.	13460.	22259.	43271.
1972	17838.	13644.	4140.	0	0	1148.	2451.	17523.	6710.	23885.	0	0	87340.
1973	865.	1603.	0	0	0	0	614.	63.	832.	13628.	59576.	4984.	82165.
AVE.	9096.	6992.	2157.	0	0	104.	1246.	3410.	1452.	6641.	17315.	15082.	63495.

IRRIGATION RELEASES ACRE FEET 13 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	6548.	0	0	0	0	3362.	6682.	820.	3914.	8354.	5817.	35497.
1965	23732.	11605.	2734.	0	0	0	0	3223.	2002.	3976.	8536.	31276.	87084.
1966	8946.	11607.	4227.	0	0	0	0	2956.	847.	30.	23623.	27819.	80055.
1967	17339.	5580.	1936.	0	0	0	16.	0	0	0	21738.	13409.	60018.
1968	13088.	9098.	3928.	0	0	0	1439.	1485.	1796.	1873.	11811.	30250.	74769.
1969	8914.	12260.	3960.	0	0	0	5194.	2645.	1681.	10056.	2121.	3503.	50334.
1970	3540.	4439.	2895.	0	0	0	226.	735.	1279.	10736.	41251.	27815.	92915.
1971	0	0	0	0	0	0	401.	2196.	0	4955.	13460.	22259.	43271.
1972	17838.	13644.	6023.	0	0	388.	2451.	17523.	6710.	22367.	0	0	86944.
1973	865.	366.	0	0	0	0	614.	63.	832.	13628.	59576.	10880.	86824.
AVE.	8569.	6832.	2337.	0	0	35.	1246.	3410.	1452.	6503.	17315.	15730.	63428.

13 - 17 REGULATION
TABLE 5D

IRRIGATION RELEASES ACRE FEET 13 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	2685.	0	0	0	0	3362.	6682.	820.	3914.	8354.	5817.	31634.
1965	23732.	11605.	2734.	0	0	0	0	3223.	2002.	3976.	8536.	31276.	87084.
1966	8946.	11607.	3404.	0	0	0	0	2956.	847.	30.	23623.	27819.	79232.
1967	1113.	257.	1663.	0	0	0	0	0	0	0	21738.	13409.	38180.
1968	13088.	1649.	2245.	0	0	0	1439.	1485.	1796.	1873.	11811.	30250.	65637.
1969	8914.	4182.	3316.	0	0	0	5194.	2645.	1681.	10056.	2121.	3503.	41612.
1970	3540.	4439.	2895.	0	0	0	226.	735.	1279.	10736.	41251.	8358.	73458.
1971	0	0	0	0	0	0	401.	2196.	0	4955.	13460.	22259.	43271.
1972	15527.	3584.	0	0	0	0	554.	13300.	6710.	19086.	0	0	58761.
1973	865.	253.	0	0	0	0	614.	63.	832.	13628.	42697.	0	58952.
AVE.	6884.	3660.	1478.	0	0	0	1072.	3026.	1452.	6205.	15781.	12972.	52529.

IRRIGATION RELEASES ACRE FEET 13 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	4548.	10506.	608.	0	0	0	3362.	6682.	820.	3914.	8354.	5817.	44611.
1965	23732.	11605.	1089.	0	0	0	0	3223.	2002.	3976.	8536.	31276.	85438.
1966	8946.	11607.	3087.	0	0	0	0	2956.	847.	30.	23623.	26659.	77755.
1967	0	257.	1410.	0	0	0	0	0	0	0	21738.	13409.	36814.
1968	13088.	396.	2499.	0	0	0	1439.	1485.	1796.	1873.	11811.	30250.	64637.
1969	8914.	5532.	2271.	0	0	0	5194.	2645.	1681.	10056.	2121.	3503.	41917.
1970	3540.	4439.	2895.	0	0	0	226.	735.	1279.	10736.	41251.	2099.	67199.
1971	0	0	0	0	0	0	401.	2196.	0	4955.	13460.	22259.	43271.
1972	12874.	4639.	0	0	0	0	554.	14690.	6710.	20700.	0	0	60167.
1973	865.	485.	0	0	0	0	614.	63.	832.	13628.	37226.	230.	53942.
AVE.	6955.	4497.	1260.	0	0	0	1072.	3152.	1452.	6352.	15284.	12318.	52341.

13 - 16 REGULATION
TABLE 5E

FLOW IN S-7 IN CFS 12 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	224.	0	0	2141.	0	0	0	2982.	66.	113.	1740.	7266.
1964	3165.	0	0	603.	1528.	1385.	510.	2279.	386.	10809.	488.	875.	22028.
1965	0	590.	3314.	0	0	5046.	6055.	1413.	2643.	4255.	413.	0	23729.
1966	467.	2408.	313.	138.	3304.	22687.	33144.	4829.	5925.	6565.	0	0	79780.
1967	0	2673.	0	0	0	12277.	8190.	3875.	4937.	11102.	0	1517.	44571.
1968	0	630.	389.	0	15713.	43926.	25269.	617.	14249.	10245.	0	0	111038.
1969	1009.	710.	8210.	2034.	6294.	19724.	3260.	5575.	6504.	6811.	4734.	608.	65482.
1970	2494.	6963.	43476.	1758.	15707.	18148.	10350.	4112.	937.	0	0	0	103945.
1971	0	1.	0	0	982.	19667.	6550.	4872.	23831.	9679.	4683.	606.	70871.
1972	575.	198.	417.	12054.	42515.	21696.	596.	249.	642.	53.	241.	0	79236.
1973	720.	682.	640.	0	543.	1003.	24410.	14520.	1895.	571.	0	555.	45539.
AVE.	766.	1372.	5160.	1508.	8066.	15051.	10758.	3849.	5903.	5469.	970.	536.	59408.

FLOW IN S-7 IN CFS 12 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	224.	0	0	2141.	0	0	0	2982.	66.	113.	1740.	7266.
1964	3165.	0	0	603.	1528.	1385.	510.	2279.	386.	10809.	488.	875.	22028.
1965	0	590.	3314.	0	0	4216.	5305.	1413.	2725.	3505.	413.	0	21481.
1966	467.	2408.	313.	408.	3304.	22687.	33144.	4128.	5925.	6565.	0	0	79349.
1967	0	2673.	679.	0	0	12277.	7847.	3136.	4937.	10352.	0	1517.	43418.
1968	0	630.	389.	0	15713.	43926.	24615.	617.	14249.	10245.	0	0	110384.
1969	1009.	710.	8597.	2034.	6294.	20308.	3260.	5575.	6504.	6811.	3984.	608.	65703.
1970	2523.	7693.	44726.	1758.	16091.	17858.	9600.	4112.	937.	0	0	0	104798.
1971	0	1.	0	0	982.	19257.	6550.	4872.	23831.	8929.	4683.	606.	69711.
1972	575.	198.	698.	12097.	42515.	21264.	596.	249.	642.	53.	241.	0	79128.
1973	720.	682.	640.	0	504.	1003.	23660.	14520.	1895.	571.	0	555.	44750.
AVE.	769.	1438.	6351.	1536.	8097.	14526.	10462.	3718.	5910.	5264.	902.	536.	58911.

12 - 17 REGULATION
TABLE 6

FLOW IN S-7 IN CFS — 12 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	324.	0	0	2541.	0	0	71.	3536.	205.	213.	1840.	8730.
1964	3465.	0	0	868.	1528.	1885.	910.	2679.	586.	12023.	702.	1275.	25921.
1965	0	890.	3276.	0	0	5196.	10196.	2194.	3243.	4876.	513.	0	30384.
1966	667.	1921.	53.	52.	1258.	23287.	42038.	5979.	7775.	7963.	0	0	90993.
1967	0	2973.	0	0	0	12477.	11669.	4630.	6087.	13167.	0	1737.	52740.
1968	0	851.	0	0	15713.	44380.	28470.	1017.	16049.	13583.	55.	0	120118.
1969	1209.	919.	4627.	2134.	6294.	20268.	6245.	7058.	8021.	8623.	5343.	1055.	71796.
1970	1998.	6963.	43876.	2508.	15157.	18569.	16033.	4612.	1326.	0	0	0	111042.
1971	0	179.	0	0	1282.	20241.	10963.	6072.	25720.	11563.	5140.	706.	81866.
1972	675.	298.	517.	9780.	42515.	21416.	1260.	481.	942.	153.	341.	0	78378.
1973	920.	882.	791.	0	595.	1755.	28625.	16338.	2223.	871.	0	855.	53855.
AVE.	812.	1473.	4831.	1395.	7898.	15407.	14219.	4648.	6864.	6639.	1119.	679.	65984.

FLOW IN S-7 IN CFS — 12 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	324.	0	0	2541.	0	0	71.	3536.	205.	213.	1840.	8730.
1964	3465.	0	0	868.	1528.	1885.	910.	2679.	586.	12023.	702.	1275.	25921.
1965	0	890.	3276.	0	0	4466.	6705.	2194.	3243.	4876.	513.	0	26163.
1966	667.	1921.	53.	190.	3304.	23287.	33384.	5979.	7775.	7963.	0	0	84523.
1967	0	2973.	0	0	0	12477.	7607.	4630.	5437.	13167.	0	1737.	48028.
1968	0	851.	0	0	15713.	43730.	24833.	1017.	16049.	13583.	55.	0	115831.
1969	1209.	919.	4627.	2134.	6294.	19824.	4295.	7058.	8021.	7973.	5343.	1055.	68752.
1970	1998.	7343.	44526.	2508.	15807.	18181.	10273.	4612.	1326.	0	0	0	106574.
1971	0	179.	0	0	1282.	19082.	8059.	6072.	25720.	10413.	4490.	706.	76503.
1972	675.	298.	517.	10430.	42515.	21235.	1260.	481.	942.	153.	341.	0	78847.
1973	920.	882.	791.	0	604.	1755.	25375.	16338.	2223.	871.	0	855.	50614.
AVE.	812.	1507.	4890.	1466.	8144.	15084.	11155.	4648.	6805.	6521.	1060.	679.	62771.

12 - 16 REGULATION
TABLE 6A

FLOW IN S-7 IN CFS 12 - 15 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	324.	0	0	2541.	0	0	71.	3536.	205.	213.	1840.	8730.
1964	3465.	0	0	868.	1528.	1885.	910.	2679.	586.	13973.	702.	1275.	27871.
1965	0	890.	1024.	0	0	5196.	7355.	2194.	3975.	4876.	513.	0	26023.
1966	667.	1921.	0	52.	2464.	23287.	33384.	5979.	9075.	8613.	0	0	85442.
1967	0	2973.	0	0	0	12477.	8004.	4630.	6087.	15117.	0	1737.	51025.
1968	0	851.	0	0	15713.	43080.	24922.	1017.	16699.	14233.	55.	0	116570.
1969	1209.	919.	4627.	2134.	6294.	19774.	4295.	7058.	8021.	9273.	5993.	1705.	71302.
1970	1998.	1745.	43876.	2508.	15807.	18098.	10273.	4612.	1652.	18.	0	0	100587.
1971	0	179.	0	0	1282.	20241.	8059.	6072.	26370.	12863.	5140.	706.	80912.
1972	675.	298.	517.	9780.	42515.	21416.	1260.	481.	942.	153.	341.	0	78378.
1973	920.	882.	791.	0	643.	1755.	25375.	16338.	3523.	871.	0	855.	51953.
AVE.	812.	998.	4621.	1395.	8072.	15201.	11258.	4648.	7315.	7290.	1178.	738.	63527.

FLOW IN S-7 IN CFS 12 - 15 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	324.	0	0	2541.	0	0	71.	3536.	205.	213.	1840.	8730.
1964	3465.	0	0	868.	1528.	1885.	910.	2679.	586.	13323.	702.	1275.	27221.
1965	0	890.	1024.	0	0	4466.	6705.	2194.	4625.	4876.	513.	0	25293.
1966	667.	1921.	0	52.	1834.	23287.	33273.	5979.	9075.	8613.	0	0	84701.
1967	0	2973.	0	0	0	12477.	7607.	4630.	6087.	14467.	0	1737.	49978.
1968	0	851.	0	0	15713.	43080.	24833.	1017.	16049.	14233.	55.	0	115831.
1969	1209.	919.	4627.	2134.	6294.	19824.	4295.	7058.	8021.	8623.	5993.	1055.	70052.
1970	1998.	1745.	44526.	2508.	15807.	17510.	10273.	4612.	1652.	18.	0	0	101049.
1971	0	170.	0	0	1282.	19118.	8059.	6072.	26370.	12213.	5140.	706.	79139.
1972	675.	298.	517.	9780.	42515.	21205.	1260.	481.	942.	153.	341.	0	78167.
1973	920.	882.	791.	0	604.	1755.	25375.	16338.	3523.	1521.	0	855.	52564.
AVE.	812.	998.	4680.	1395.	8011.	15001.	11145.	4648.	7315.	7113.	1178.	679.	62975.

12 - 15 REGULATION
TABLE 6B

FLOW IN S-7 IN CFS — 12 - 14 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	526.	0	0	2941.	0	0	237.	4136.	405.	313.	1940.	10498.
1964	3765.	0	0	1195.	1528.	4700.	1356.	3132.	891.	15523.	1568.	1675.	35333.
1965	0	1306.	1324.	0	0	5551.	12892.	3695.	4322.	7043.	613.	0	36746.
1966	924.	2230.	0	152.	926.	27408.	43254.	10589.	12076.	12007.	90.	77.	109733.
1967	0	3444.	0	0	0	12689.	13120.	10141.	6675.	19580.	0	2037.	67686.
1968	0	1151.	16.	0	15713.	47080.	31815.	1557.	18299.	16702.	155.	0	132488.
1969	1420.	1119.	5327.	2234.	6294.	25590.	5974.	9669.	9740.	11418.	7457.	2105.	88347.
1970	2618.	8887.	47006.	2508.	15907.	24791.	15456.	7473.	2053.	684.	71.	0	127454.
1971	0	379.	0	0	1666.	19292.	13083.	7428.	29873.	16763.	7290.	806.	96580.
1972	858.	452.	693.	12301.	42515.	27316.	2036.	881.	1310.	253.	441.	18.	89074.
1973	1176.	1082.	991.	0	776.	4923.	30324.	24643.	5411.	2271.	0	1155.	72752.
AVE.	978.	1871.	5032.	1672.	8024.	18122.	15392.	7222.	8617.	9332.	1636.	892.	78790.

FLOW IN S-7 IN CFS — 12 - 14 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	526.	0	0	2941.	0	0	237.	4136.	405.	313.	1940.	10498.
1964	3765.	0	0	1195.	1528.	4700.	1356.	3132.	891.	14473.	1018.	1675.	34233.
1965	0	1306.	1324.	0	0	5551.	12919.	3695.	4322.	6347.	613.	0	36077.
1966	924.	2230.	0	152.	540.	26658.	43252.	10141.	10976.	11457.	90.	77.	106697.
1967	0	3444.	0	0	0	12689.	12570.	10141.	6675.	18538.	0	2037.	66094.
1968	0	1151.	16.	0	15277.	47080.	31989.	1417.	17943.	16272.	155.	0	131300.
1969	1420.	1119.	5327.	2234.	6294.	25040.	5974.	9119.	9740.	10868.	7457.	1555.	86147.
1970	2618.	3270.	43771.	2508.	15907.	25341.	15567.	7473.	2053.	684.	71.	0	119263.
1971	0	379.	0	0	1666.	19292.	12207.	7428.	29222.	16213.	7290.	806.	94503.
1972	858.	452.	693.	12301.	42515.	27316.	2036.	881.	1310.	253.	441.	18.	89074.
1973	1176.	1082.	991.	0	767.	2737.	29774.	24072.	5411.	2271.	0	1155.	69436.
AVE.	978.	1360.	4738.	1672.	7949.	17673.	15240.	7067.	8425.	8935.	1586.	842.	76666.

12 - 14 REGULATION
TABLE 6C

FLOW IN S-7 IN CFS — 13 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	224.	0	0	2141.	0	0	0	2982.	66.	113.	1740.	7266.
1964	3165.	0	0	1353.	1480.	1385.	510.	2279.	386.	10809.	488.	875.	22730.
1965	0	590.	3314.	0	0	5532.	5305.	1413.	2643.	4255.	413.	0	23465.
1966	467.	2408.	313.	1507.	0	22687.	27448.	4128.	5925.	6565.	0	0	71448.
1967	0	2673.	793.	0	0	12277.	6139.	3136.	4937.	12602.	0	1517.	44074.
1968	0	630.	389.	0	12557.	38312.	20974.	617.	14249.	12495.	0	0	100223.
1969	1009.	719.	8210.	3189.	1951.	20218.	3260.	5575.	6504.	6811.	4734.	1358.	63538.
1970	2494.	6963.	43476.	1758.	11957.	14238.	8850.	4112.	937.	0	0	0	94785.
1971	0	1.	0	0	982.	19003.	6550.	4872.	23831.	9679.	4683.	606.	70207.
1972	575.	198.	417.	12097.	37942.	18047.	596.	249.	642.	53.	241.	0	71057.
1973	720.	682.	640.	0	495.	1003.	22910.	13770.	1895.	571.	0	555.	43241.
AVE.	766.	1372.	5232.	1809.	6319.	13682.	9322.	3650.	5903.	5810.	970.	605.	55639.

FLOW IN S-7 IN CFS — 13 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	224.	0	0	2141.	0	0	0	2982.	66.	113.	1740.	7266.
1964	3165.	0	0	1180.	1480.	1385.	510.	2279.	386.	10809.	488.	875.	22557.
1965	0	590.	3314.	0	0	4782.	5305.	1413.	2643.	4255.	413.	0	22715.
1966	467.	2408.	313.	1507.	0	22687.	26838.	4128.	5925.	6565.	0	0	70838.
1967	0	2673.	793.	0	0	12277.	6689.	3136.	4937.	11102.	0	1517.	43124.
1968	0	630.	389.	0	12557.	38312.	20974.	617.	14249.	11745.	0	0	99473.
1969	1009.	719.	8152.	3230.	1951.	20218.	3260.	5575.	6504.	6811.	4734.	608.	62771.
1970	2523.	7343.	44226.	1758.	11957.	13738.	8850.	3362.	937.	0	0	0	94694.
1971	0	1.	0	0	982.	18253.	6550.	4872.	23831.	10429.	4683.	606.	70207.
1972	575.	198.	698.	12097.	38584.	17669.	596.	249.	642.	53.	241.	0	71602.
1973	720.	682.	640.	0	495.	1003.	23660.	13770.	1895.	571.	0	555.	43991.
AVE.	769.	1406.	5320.	1797.	6377.	13666.	9385.	3582.	5903.	5673.	970.	536.	55385.

FLOW IN S-7 IN CFS   13 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	324.	0	0	2541.	0	0	71.	3536.	205.	213.	1840.	8730.
1964	3465.	0	0	1445.	1528.	1685.	910.	2679.	586.	12673.	702.	1275.	27148.
1965	0	890.	3276.	0	0	5682.	7355.	2194.	3243.	4876.	513.	0	28029.
1966	667.	1921.	53.	1507.	0	23287.	31358.	5979.	7775.	8269.	0	0	80816.
1967	0	2973.	0	0	0	12477.	7289.	4630.	5437.	13817.	0	1737.	48360.
1968	0	851.	2.	0	15183.	40116.	23957.	1017.	16049.	13583.	55.	0	110813.
1969	1209.	919.	5664.	3189.	4617.	18524.	4295.	7058.	8021.	8623.	5343.	1055.	68517.
1970	1998.	6963.	43876.	2508.	13207.	16038.	10168.	4612.	1652.	18.	0	0	101040.
1971	0	179.	0	0	1282.	18742.	8709.	6072.	26370.	11563.	5140.	706.	78763.
1972	675.	298.	517.	12497.	41698.	18786.	1260.	481.	942.	153.	341.	0	77648.
1973	920.	882.	791.	0	595.	1755.	25375.	16338.	2223.	871.	0	855.	50605.
AVE.	812.	1473.	4925.	1922.	7332.	14299.	10971.	4648.	6894.	6786.	1119.	679.	61861.

FLOW IN S-7 IN CFS   13 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	324.	0	0	2541.	0	0	71.	3536.	205.	213.	1840.	8730.
1964	3465.	0	0	2745.	1528.	1685.	910.	2679.	586.	13323.	1352.	1275.	29748.
1965	0	890.	3314.	0	0	4546.	8005.	2194.	3711.	5593.	513.	0	28766.
1966	667.	1921.	53.	1507.	0	23287.	33510.	5979.	8425.	6457.	0	0	84306.
1967	0	2973.	0	0	0	12477.	8004.	4630.	6087.	16417.	0	1737.	52325.
1968	0	851.	0	0	15277.	42430.	25896.	1017.	16049.	14651.	55.	0	116226.
1969	1209.	919.	5722.	3288.	5901.	19174.	4295.	7058.	8021.	10573.	5993.	1055.	73208.
1970	1998.	10430.	47300.	2508.	13857.	17909.	10168.	5262.	1326.	90.	0	0	110848.
1971	0	179.	0	0	1282.	19082.	8059.	6072.	27020.	14163.	5140.	706.	81703.
1972	675.	298.	517.	13768.	42515.	19905.	1260.	481.	942.	153.	341.	0	80855.
1973	920.	882.	791.	0	595.	1755.	26025.	16988.	4290.	1521.	0	855.	54622.
AVE.	812.	1788.	5245.	2165.	7591.	14768.	11467.	4766.	7272.	7786.	1237.	679.	65576.

13 - 16 REGULATION
TABLE 6E

FLOW IN S -8 WITH 12.5 - 14.0 AND 12 - 17 REGULATION CFS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2421.	0	0	0	0.	0	0	305.	2726.
1964	0	0	0	0	0	0	0.	1032.	189.	6650.	180.	604.	8655.
1965	0	1250.	5116.	0	0	4048.	3980.	1150.	3510.	9520.	300.	0.	28874.
1966	1237.	1606.	1670.	560.	330.	9618.	22113.	6692.	0	661.	0	0	44687.
1967	0	272.	0	0	0	13852.	6271.	1674.	1803.	11580.	0	0	35452.
1968	0	390.	494.	0	6332.	39109.	33336.	773.	2192.	6258.	188.	235.	89308.
1969	551.	34.	6204.	141.	603.	15352.	111.	4392.	0.	7911.	3446.	1478.	40222.
1970	2090.	4532.	43436.	7036.	7802.	8838.	9192.	3820.	227.	389.	0	0	87362.
1971	0	0	0	0	591.	3782.	2329.	370.	13307.	10496.	4753.	0	35628.
1972	0	102.	4.	4297.	18279.	16986.	0	737.	251.	0	0	0	40655.
1973	0	0	0	0	0	90.	7060.	1709.	2077.	494.	0	0	11430.
AVE.	352.	744.	5175.	1094.	3305.	10171.	7672.	2032.	2141.	4905.	806.	238.	38636.

FLOW IN S -8 WITH 12.5 - 14.5 AND 12 - 17 REGULATION CFS TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1821.	0	0	0	0.	0	0	305.	2126.
1964	0	0	0	0	0	0	0	1032.	189.	6230.	73.	123.	7647.
1965	0	1250.	3580.	0	0	3577.	3314.	1150.	4055.	6368.	301.	0	23595.
1966	818.	2040.	2327.	813.	330.	10207.	22492.	5942.	0	0	0	0	44969.
1967	0	272.	0.	0	0	14212.	6537.	965.	1803.	8913.	0	116.	32818.
1968	0	390.	797.	0	6994.	39532.	33514.	773.	1849.	6163.	143.	0	90155.
1969	457.	254.	7679.	148.	720.	15664.	371.	4354.	0.	7719.	2056.	50.	39473.
1970	2536.	5147.	44788.	7391.	8705.	8350.	8461.	3820.	0	0	0	0	89198.
1971	0	0	0	0	591.	3707.	2236.	299.	13007.	7597.	4996.	0	32434.
1972	0	518.	263.	4410.	18365.	17169.	0	737.	251.	0	0	0	41713.
1973	0	0	0	0	0	0	6610.	1709.	609.	0	0	0	8928.
AVE.	346.	897.	5403.	1160.	3411.	10220.	7594.	1889.	1976.	3908.	688.	54.	37550.

12 - 17 REGULATION
TABLE 7

FLOW IN S -8 WITH 12.5 - 14.0 AND 12 - 16 REGULATION CFS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1927.	0	0	0	0	0	0	405.	2332.
1964	0	0	0	0	0	0	0.	1232.	330.	9430.	593.	994.	12579.
1965	0	650.	4502.	0	0	4103.	7190.	1550.	4410.	11040.	400.	0.	33846.
1966	1599.	458.	1080.	0.	24.	10590.	30166.	7453.	64.	1722.	0.	0	53155.
1967	0	372.	0	0	0	13952.	11251.	1424.	2765.	14419.	0	0	44183.
1968	0	190.	24.	0	6344.	39400.	38675.	1785.	2992.	10915.	286.	237.	100848.
1969	651.	33.	3026.	141.	603.	15468.	2905.	5091.	0.	10443.	2903.	1571.	42835.
1970	1474.	4529.	43845.	7036.	7552.	8749.	14590.	4377.	374.	679.	0.	0	93205.
1971	0	0	1.	0	644.	4007.	3222.	611.	14502.	13311.	5067.	0	41365.
1972	0	194.	4.	1609.	18279.	17014.	57.	866.	351.	0	0	0	38374.
1973	0	0	0	0	0	0	9260.	2301.	2323.	915.	0	0	14799.
AVE.	339.	584.	4771.	799.	3216.	10298.	10665.	2426.	2556.	6625.	841.	291.	43411.

FLOW IN S -8 WITH 12.5 - 14.5 AND 12 - 16 REGULATION CFS TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1927.	0	0	0	0	0	0	405.	2332.
1964	0	0	0	0	0	0	0	1232.	330.	8530.	593.	994.	11679.
1965	0	650.	3258.	0	0	3589.	3830.	1550.	4110.	10611.	401.	0	27999.
1966	1230.	951.	1496.	633.	330.	10700.	22690.	7453.	64.	764.	0	0	46310.
1967	0	373.	2.	0	0	14625.	6760.	1876.	2115.	12753.	0	316.	38819.
1968	0	506.	332.	0	6994.	39201.	34320.	1785.	2617.	10706.	144.	0	96606.
1969	557.	253.	3751.	148.	720.	15782.	1044.	5091.	0.	9212.	3049.	150.	39757.
1970	1370.	5140.	45099.	7391.	8805.	7733.	9348.	4377.	74.	21.	0	0	89358.
1971	0	0	35.	0	791.	5048.	2636.	611.	14202.	11653.	4641.	0	39617.
1972	0	609.	108.	2324.	18370.	17297.	57.	866.	351.	0	0	0	39983.
1973	0	0	0	0	0	0	7510.	2301.	728.	1.	0	0	10540.
AVE.	287.	771.	4916.	954.	3449.	10361.	8018.	2467.	2236.	5841.	803.	170.	4027[illegible].

12 - 16 REGULATION
TABLE 7A

FLOW IN S -A WITH 12.5 - 14.0 AND 12 - 15 REGULATION CFS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2527.	0	0	0	0	0	0	405.	2932.
1964	0	0	0	0	0	0	0.	1232.	1748.	10835.	593.	994.	15402.
1965	188.	1540.	2008.	0	0	4103.	4770.	1550.	6663.	11039.	400.	0.	32261.
1966	1649.	461.	31.	0.	28.	9990.	22161.	7453.	1528.	2544.	0.	0	45845.
1967	0	372.	0	0	0	13952.	7074.	1724.	2906.	16760.	0	0	42788.
1968	0	190.	21.	0	6128.	38117.	34087.	1785.	4542.	11570.	379.	234.	97052.
1969	650.	33.	3026.	141.	603.	15345.	600.	5288.	0.	11511.	4340.	2223.	43761.
1970	1475.	794.	43846.	7036.	7902.	8518.	9328.	4377.	957.	1186.	0.	0	85420.
1971	0	0	1.	0	644.	4007.	2636.	611.	17252.	14606.	5064.	0	44821.
1972	0	193.	4.	1608.	18279.	17014.	57.	866.	351.	0	0	0	38372.
1973	0	0	0	0	0	0	7510.	2592.	4264.	1104.	0	0	15469.
AVE.	360.	326.	4449.	799.	3283.	10095.	8020.	2498.	3656.	7378.	980.	351.	42193.

FLOW IN S -A WITH 12.5 - 14.5 AND 12 - 15 REGULATION CFS TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1927.	0	0	0	0	0	0	405.	2332.
1964	0	0	0	0	0	0	0	1232.	848.	10485.	593.	994.	14152.
1965	0	650.	1983.	0	0	3432.	4120.	1550.	6713.	10612.	400.	0	29460.
1966	1230.	772.	425.	3.	28.	10699.	22254.	7453.	1403.	1574.	0	0	45840.
1967	0	373.	2.	0	0	14626.	6760.	1876.	2906.	14628.	0	316.	41486.
1968	0	506.	326.	0	6994.	38544.	34313.	1785.	3892.	11372.	142.	0	97874.
1969	557.	253.	3754.	148.	720.	15785.	1044.	5091.	0.	10151.	3503.	150.	41157.
1970	1378.	1336.	45100.	7392.	8805.	8097.	9348.	4377.	957.	195.	0.	0	86984.
1971	0	0	36.	0	644.	5118.	2336.	547.	17252.	12658.	5306.	0	43896.
1972	0	607.	108.	1724.	18369.	16980.	57.	866.	351.	0	0	0	39062.
1973	0	0	0	0	0	0	7510.	2301.	3250.	1022.	0	0	14083.
AVE.	288.	409.	4703.	842.	3408.	10298.	7976.	2462.	3416.	6609.	904.	170.	41484.

12 - 15 REGULATION
TABLE 7B

FLOW IN S -R WITH 12.5 - 14.0 AND 12 - 14 REGULATION CFS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2728.	0	0	0	5.	0	0	505.	3238.
1964	85.	0	0	0	0	801.	0.	2032.	3000.	12508.	1789.	2741.	22955.
1965	366.	2235.	2409.	0	0	5827.	10519.	3195.	7847.	14505.	500.	0.	47404.
1966	2301.	684.	30.	0.	52.	12610.	31251.	12421.	3326.	4271.	0.	0	66946.
1967	0	479.	0	0	0	15552.	12699.	6732.	3618.	20814.	0	0	59894.
1968	0	590.	23.	0	6344.	42078.	41714.	3499.	5554.	13963.	285.	236.	114286.
1969	751.	84.	3626.	141.	603.	20300.	2568.	8803.	0.	12980.	4787.	2357.	57001.
1970	1987.	4153.	47981.	7036.	8002.	13127.	14314.	8408.	1257.	3050.	0.	0	109316.
1971	0	0	1.	0	744.	4502.	6412.	1729.	20918.	18354.	6882.	0	59542.
1972	0	365.	4.	3608.	18280.	22170.	157.	1066.	498.	0	0	0	46148.
1973	0	0	0	0	0	1105.	10310.	12564.	6962.	1392.	0	64.	32397.
AVE.	499.	781.	4916.	981.	3341.	12552.	11813.	5495.	4817.	9258.	1295.	537.	56284.

FLOW IN S -R WITH 12.5 - 14.5 AND 12 - 14 REGULATION CFS TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2428.	0	0	0	5.	0	0	505.	2938.
1964	85.	0	0	0	0	801.	0.	2032.	2655.	11967.	1144.	1793.	20477.
1965	0	2609.	2902.	0	0	5684.	10081.	3195.	7847.	12920.	501.	0	45738.
1966	1886.	1132.	449.	3.	52.	13724.	32038.	12733.	2593.	2283.	0.	0	66893.
1967	0	525.	2.	0	0	15318.	12502.	6732.	3618.	17734.	0	516.	56948.
1968	0	785.	329.	0	6994.	42528.	42482.	3051.	5303.	13224.	142.	0	114838.
1969	657.	303.	4349.	148.	720.	21040.	2568.	7953.	0.	11524.	4148.	381.	53790.
1970	1877.	2496.	45280.	7389.	8905.	13806.	14398.	8408.	1257.	1015.	0.	0	104831.
1971	0	0	36.	0	744.	5402.	5697.	1729.	20368.	16207.	7041.	0	57223.
1972	0	776.	107.	3603.	18374.	22435.	157.	1066.	498.	0	0	0	47017.
1973	0	0	0	0	0	635.	10360.	12314.	6475.	1178.	0	64.	31226.
AVE.	410.	784.	4859.	1013.	3474.	12670.	11844.	5383.	4602.	8005.	1180.	296.	54720.

12 - 14 REGULATION
TABLE 7C

FLOW IN S -8 WITH 12.5 - 14.0 AND 13 - 17 REGULATION CFS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1594.	0	0	0	0.	0	0	305.	1899.
1964	0	0	0.	123.	0	0	0	1032.	189.	8330.	180.	604.	10458.
1965	0	1250.	5120.	0	0	3553.	3230.	1150.	3510.	9810.	300.	0.	27923.
1966	1235.	1605.	1670.	1698.	0	9520.	16239.	5942.	0	1430.	0.	0	39338.
1967	0	272.	0	0	0	13252.	4904.	965.	1803.	13572.	0	0	34769.
1968	0	390.	493.	0	4236.	33129.	28830.	773.	2192.	10279.	380.	235.	80936.
1969	550.	33.	6202.	203.	603.	14760.	111.	4354.	0.	9192.	3446.	2227.	41682.
1970	2090.	4531.	43436.	7036.	4479.	6107.	7692.	3820.	227.	488.	0.	0	79906.
1971	0	0	1.	0	591.	4169.	2329.	299.	13307.	11605.	4763.	0	37063.
1972	0	101.	4.	4297.	15432.	13712.	0	737.	251.	0	0	0	34534.
1973	0	0	0	0	0	0	6160.	809.	1176.	905.	0	0	9049.
AVE.	352.	744.	5175.	1214.	2449.	8928.	6318.	1807.	2060.	5964.	824.	306.	36142.

FLOW IN S -8 WITH 12.5 - 14.5 AND 13 - 17 REGULATION CFS TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1594.	0	0	0	0.	0	0	305.	1899.
1964	0	0	0.	31.	0	0	0	1032.	189.	7130.	180.	604.	9166.
1965	0	1250.	3580.	0	0	2803.	3279.	1362.	4205.	9285.	300.	598.	26662.
1966	1756.	1742.	2123.	1700.	0	10170.	16508.	6761.	0	465.	0	0	41224.
1967	0	457.	0	0	0	13895.	6139.	719.	1803.	10814.	0	116.	33943.
1968	0.	390.	766.	0	4478.	33548.	29040.	2545.	1805.	9317.	145.	481.	82516.
1969	710.	47.	6937.	206.	603.	14805.	389.	4257.	0.	8619.	2805.	2617.	41996.
1970	2698.	4909.	44572.	7250.	4480.	5478.	8655.	3619.	0	0.	0	0	81661.
1971	0	0	31.	0	591.	5133.	2236.	299.	12708.	11057.	5005.	1.	37061.
1972	19.	308.	187.	4341.	15353.	13119.	221.	737.	251.	0	0	0	34536.
1973	0	0	0	0	0	0	6357.	619.	1592.	0	0	0	8567.
AVE.	471.	828.	5291.	1230.	2464.	8996.	6620.	1995.	2050.	5153.	767.	429.	36294.

13 - 17 REGULATION
TABLE 7D

FLOW IN S -A WITH 12.5 - 14.0 AND 13 - 16 REGULATION CFS

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1927.	0	0	0	0	0	0	405.	2332.
1964	0	0	0.	31.	0	0	0.	1232.	848.	10135.	593.	994.	13833.
1965	250.	1563.	4560.	0	0	3803.	4729.	1770.	4618.	10946.	400.	0.	32639.
1966	1600.	459.	1080.	1698.	0	10011.	20226.	7453.	294.	1821.	0.	0	44643.
1967	0	372.	0	0	0	14252.	6424.	1821.	2115.	15351.	0	0	40336.
1968	0	190.	23.	0	5919.	34849.	32766.	1785.	3892.	10914.	286.	236.	90861.
1969	651.	33.	4326.	203.	603.	13916.	720.	5733.	0.	10699.	3144.	1497.	41526.
1970	1477.	4531.	43845.	7036.	5929.	7265.	8992.	4377.	791.	1078.	0.	0	85322.
1971	0	0	1.	0	791.	4635.	3950.	803.	16052.	13311.	5067.	0	44609.
1972	0	194.	4.	4298.	17315.	13629.	57.	866.	351.	0	0	0	36913.
1973	0	0	0	0	0	190.	7510.	3142.	2500.	917.	0	0	14259.
AVE.	362.	668.	4894.	1206.	2953.	9341.	7761.	2635.	2860.	6834.	863.	285.	40661.

FLOW IN S -A WITH 12.5 - 14.5 AND 13 - 16 REGULATION CFS TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1927.	0	0	0	0	0	0	705.	2632.
1964	0	258.	0.	396.	0	29.	0.	1232.	2279.	11085.	943.	1294.	17516.
1965	0	1740.	3580.	0	0	6189.	4479.	1770.	6663.	11018.	400.	0	35839.
1966	1230.	97.	60.	249.	0	11056.	20361.	11214.	4467.	2814.	0	0	51548.
1967	0	672.	0	0	0	15293.	6869.	4243.	2906.	17613.	0	316.	47913.
1968	0	506.	305.	0	2669.	38854.	34365.	5249.	4037.	10659.	1900.	0	98544.
1969	745.	274.	4758.	71.	195.	16181.	1310.	6435.	0	11620.	5179.	688.	47457.
1970	1494.	5286.	43624.	6196.	5905.	9903.	10414.	8674.	3779.	2572.	0	0	97846.
1971	0	0	11.	0	791.	7559.	3300.	803.	18202.	14616.	3352.	0	48634.
1972	0	94.	15.	2880.	13616.	16709.	1113.	866.	1088.	0	0	0	36381.
1973	190.	0	0	0	0	461.	7860.	3770.	4350.	140.	0	264.	17035.
AVE.	333.	812.	4759.	890.	2282.	11112.	8188.	4023.	4343.	7467.	1070.	297.	45577.

13 - 16 REGULATION
TABLE 7E

FLOW TO CONSERVATION AREA ACRE FEET 12 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	2394.	1024.	0	0	0	0	4275.	0	7693.
1965	13901.	1051.	20209.	2275.	43.	0	11390.	10666.	16764.	13514.	4035.	0	93848.
1966	0	11815.	18055.	2339.	178.	5688.	36796.	32709.	22740.	19287.	1060.	0	150866.
1967	0	0	3625.	0	0.	3116.	23400.	24812.	8373.	32730.	2102.	0	98158.
1968	0	0	19044.	6896.	2506.	18516.	30229.	2.	21328.	26155.	2142.	0	128818.
1969	0	1085.	28285.	8732.	1653.	10707.	4741.	15035.	3.	4159.	20895.	13322.	108616.
1970	42818.	36857.	45475.	17373.	775.	14150.	24522.	18940.	1061.	0	0	0	201970.
1971	0	0	0	0	0	0	10119.	2112.	34083.	26536.	27207.	0	100058.
1972	0	0	7490.	4037.	8644.	14406.	0	0	0	0	0	0	34577.
1973	0	0	0	0	2.	0	14429.	42466.	24211.	0	0	0	81108.
AVE.	5156.	4610.	12926.	3787.	1472.	6164.	14148.	13340.	11688.	11307.	5611.	1211.	91428.

FLOW TO CONSERVATION AREA ACRE FEET 12 - 17 REGULATION WITH TOE -

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	1852.	0	0	0	0	0	0	0	1852.
1965	10127.	2115.	21761.	2969.	73.	0	9208.	6442.	10634.	10023.	4052.	0	77404.
1966	0	13118.	19682.	3515.	240.	6008.	36706.	31619.	17182.	9306.	1069.	0	138445.
1967	0	0	6351.	0	6.	3199.	21125.	24969.	4351.	27652.	1064.	0	88716.
1968	0	0	23919.	7618.	2814.	18502.	30313.	0	10538.	17508.	2123.	0	113335.
1969	0	2168.	28338.	9372.	1218.	9819.	2534.	8570.	0	0	10378.	12421.	84819.
1970	44327.	39806.	45280.	18103.	833.	13613.	23192.	18686.	0	0	0	0	203841.
1971	0	0	0	0	0	0	7184.	0	21567.	22412.	25124.	0	76286.
1972	0	0	9385.	5623.	9724.	14276.	0	0	0	0	0	0	39009.
1973	0	0	0	0	0.	0	10743.	39286.	23150.	0	0	0	73179.
AVE.	4950.	5201.	14065.	4291.	1524.	5947.	12819.	11779.	7947.	7900.	3983.	1129.	81535.

12 - 17 REGULATION
TABLE 8

FLOW TO CONSERVATION AREA ACRE FEET 12 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	2363.	7.	0	0	0	9400.	9321.	0	21091.
1965	0	0	12414.	1128.	50.	0	3172.	3236.	14556.	41340.	4040.	0	79937.
1966	0	0	8012.	1712.	207.	6135.	10983.	22713.	19422.	45649.	1058.	0	115891.
1967	0	0	0	0	0	2.	8620.	20504.	6483.	52851.	2105.	0	90565.
1968	0	0	0	4896.	2325.	18021.	13236.	0	12387.	41294.	5151.	0	97310.
1969	0	0	15007.	8576.	1640.	9729.	3.	4240.	0	24412.	23085.	13706.	100399.
1970	13355.	36840.	45059.	16946.	781.	14107.	6402.	14257.	1.	12891.	0	0	160641.
1971	0	0	0	0	0	0	6.	0	24076.	51265.	24050.	0	99398.
1972	0	0	0	7.	8103.	14177.	0	0	0	0	0	0	22287.
1973	0	0	0	0	2.	0	5119.	33815.	23545.	14514.	0	0	76994.
AVE.	1214.	3349.	7318.	3024.	1406.	5653.	4322.	8979.	9134.	26693.	6255.	1246.	78592.

FLOW TO CONSERVATION AREA ACRE FEET 12 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	1529.	0	0	0	0	1068.	8270.	0	10868.
1965	0	0	12618.	2273.	78.	0	8373.	4303.	10541.	35013.	3218.	0	76417.
1966	0	0	8324.	2370.	253.	5682.	34144.	24860.	13415.	40940.	1068.	0	131057.
1967	0	0	0	0	0	0	16143.	20656.	3264.	50387.	1065.	0	91515.
1968	0	0	0	5702.	2450.	18749.	28747.	0	3190.	37261.	2149.	0	98247.
1969	0	0	15301.	9349.	1487.	9847.	2129.	2118.	0	16801.	17954.	11646.	86631.
1970	14436.	39524.	45274.	17713.	780.	13154.	21075.	16415.	0	5094.	0	0	173466.
1971	0	0	0	0	0	0	1067.	0	13656.	48436.	27055.	0	90214.
1972	0	0	0	2.	8445.	13495.	0	0	0	0	0	0	21942.
1973	0	0	0	0	0.	0	8059.	32771.	20872.	11315.	0	0	73016.
AVE.	1312.	3593.	7411.	3401.	1366.	5539.	10885.	9193.	5903.	22392.	5525.	1059.	77579.

12 -16 REGULATION
TABLE 8A

FLOW TO CONSERVATION AREA ACRE FEET 12 - 15 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	2298.	5.	0	0	4288.	22037.	9650.	0	38278.
1965	0	0	0	3.	37.	0	9874.	8589.	40214.	42343.	4304.	0	105364.
1966	0	0	0	0	34.	5324.	33833.	29044.	44654.	44522.	2108.	0	159518.
1967	0	0	0	0	0	0	17650.	22659.	33431.	50557.	2113.	0	126409.
1968	0	0	0	0	538.	17673.	28793.	0	41247.	39770.	6374.	0	134394.
1969	0	0	0	4404.	1045.	9771.	3577.	8518.	24599.	24017.	24981.	11920.	112833.
1970	15012.	23968.	44743.	16911.	687.	13568.	22798.	19810.	25936.	16222.	0	0	199656.
1971	0	0	0	0	0	0	4241.	0	48855.	45579.	26341.	0	125017.
1972	0	0	0	0	8383.	14182.	0	0	0	0	0	0	22564.
1973	0	0	0	0	2.	0	11915.	37212.	48270.	15163.	0	0	112562.
AVE.	1365.	2179.	4068.	1938.	1184.	5502.	12062.	11439.	28316.	27292.	6897.	1084.	103327.

FLOW TO CONSERVATION AREA ACRE FEET 12 - 15 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	1529.	0	0	0	2.	23165.	9632.	0	34328.
1965	0	0	0	3.	34.	0	7148.	5322.	36925.	38023.	3230.	0	90685.
1966	0	0	0	0	20.	5207.	33014.	24751.	41406.	41262.	1058.	0	146717.
1967	0	0	0	0	0	0	12748.	20479.	31215.	50472.	1062.	0	115976.
1968	0	0	0	0	876.	17075.	27678.	0	35700.	36388.	3199.	0	120916.
1969	0	0	0	4444.	1055.	9269.	2119.	2120.	22420.	23112.	22810.	13090.	100441.
1970	15004.	22963.	45782.	17779.	791.	13126.	21060.	16409.	23736.	13016.	0	0	189665.
1971	0	0	0	0	0	0	0	0	41400.	44078.	25241.	0	110720.
1972	0	0	0	0	7853.	13042.	0	0	0	0	0	0	20894.
1973	0	0	0	0	0.	0	7871.	32712.	46012.	10856.	0	0	97451.
AVE.	1364.	2088.	4162.	2021.	1105.	5247.	10149.	9254.	25347.	25488.	6021.	1190.	93436.

FLOW TO CONSERVATION AREA   ACRE FEET   12 - 14 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	767.	3520.	3895.	0	7638.	17885.	12597.	1053.	47355.
1965	0	0	0	0	0	239.	9130.	19629.	22266.	36379.	3397.	0	91038.
1966	0	0	0	0	4.	3640.	19258.	23715.	21737.	36908.	2128.	0	107391.
1967	0	0	0	0	0	3415.	15787.	21378.	16086.	37040.	2108.	0	95814.
1968	0	0	0	0	347.	11620.	19271.	10614.	24119.	32166.	7611.	0	105748.
1969	0	0	0	2840.	729.	5104.	8804.	15921.	8448.	15248.	23840.	11531.	92466.
1970	14720.	4477.	18794.	10578.	144.	4780.	15304.	22037.	11163.	15292.	0	0	117290.
1971	0	0	0	0	0	0	5892.	10538.	29428.	30006.	21285.	0	97149.
1972	0	0	0	3.	4855.	6641.	1528.	0	0	0	0	0	13228.
1973	0	0	0	0.	0.	1.	13686.	25032.	24147.	15720.	0	0	78587.
AVE.	1338.	407.	1709.	1220.	622.	3560.	10232.	13533.	15003.	21513.	6633.	1144.	76915.

FLOW TO CONSERVATION AREA   ACRE FEET   12 - 14 REGULATION   WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	428.	2314.	3764.	0	5510.	18122.	8451.	4.	38593.
1965	0	0	0	0	0	1.	9108.	19576.	19546.	34632.	3218.	0	86082.
1966	0	0	0	0	1.	3380.	19058.	22807.	20252.	37185.	2114.	0	104796.
1967	0	0	0	0	0	3028.	15756.	21222.	13863.	37467.	2110.	0	93446.
1968	0	0	0	0	382.	11801.	19497.	8857.	20835.	29740.	6394.	0	97506.
1969	0	0	0	2549.	629.	5447.	9826.	14063.	6330.	15131.	20284.	12846.	87104.
1970	14747.	19087.	29552.	12829.	259.	4740.	15248.	19449.	7351.	14012.	0	0	137274.
1971	0	0	0	0	0	0	5314.	8511.	26781.	28841.	20374.	0	89820.
1972	0	0	0	1.	3706.	7318.	512.	0	0	0	0	0	11536.
1973	0	0	0	0	0	0	13681.	25011.	22125.	12174.	0	0	72991.
AVE.	1341.	1735.	2687.	1398.	491.	3457.	10160.	12681.	12963.	20664.	5722.	1168.	74468.

12 - 14 REGULATION
TABLE 8C

FLOW TO CONSERVATION AREA ACRE FEET 13 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	2314.	15676.	3451.	0	0	0	0	13159.	9395.	0	43996.
1965	13898.	1050.	20203.	12274.	0	0	13104.	8484.	15572.	43979.	5074.	0	133638.
1966	0	11786.	18012.	13447.	0	7129.	53852.	33099.	21516.	48099.	1076.	0	208017.
1967	0	0	6705.	10236.	0	0	27331.	22906.	8221.	56479.	2107.	0	133985.
1968	0	0	20168.	16178.	12017.	32911.	42113.	0	19147.	43250.	5120.	0	190904.
1969	0	1078.	28035.	16785.	6622.	5761.	1081.	11272.	0.	29874.	21809.	10342.	132660.
1970	42738.	36807.	45437.	19867.	2152.	25249.	28792.	16059.	0.	12724.	0	0	229826.
1971	0	0	0	518.	0	0	14051.	4.	32755.	57683.	25030.	0	130042.
1972	0	0	7519.	22362.	18991.	18700.	0	0	0	0	0	0	67572.
1973	0	0	0	14349.	0	0	18655.	44107.	21847.	14373.	0	0	113333.
AVE.	5149.	4611.	13490.	12881.	3930.	8159.	18089.	12357.	10824.	29056.	6328.	940.	125816.

FLOW TO CONSERVATION AREA ACRE FEET 13 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	14674.	3965.	0	0	0	0	1083.	9427.	0	29149.
1965	14887.	2122.	21801.	12946.	0	0	9880.	3223.	9302.	37969.	4057.	0	116187.
1966	0	14174.	19267.	13632.	0	5843.	51923.	29556.	13412.	42049.	1064.	0	190919.
1967	0	0	7793.	10782.	0	0	19707.	17514.	4161.	56622.	1061.	0	117640.
1968	0	0	22576.	17666.	12300.	31893.	40652.	0	5087.	41222.	2139.	0	173536.
1969	0	3230.	29633.	17965.	6037.	4627.	0	4211.	0	19349.	16946.	12464.	114462.
1970	43365.	38410.	45900.	20779.	2155.	25324.	26386.	14921.	0	4052.	0	0	221293.
1971	0	0	0	509.	0	0	8571.	0	21881.	47787.	25794.	0	104542.
1972	0	0	8241.	22760.	19101.	18529.	0	0	0	0	0	0	68631.
1973	0	0	0	12725.	0	0	12337.	34687.	19520.	10344.	0	0	89613.
AVE.	5296.	5267.	14110.	13131.	3960.	7638.	15405.	9465.	6669.	23680.	5499.	1133.	111452.

13 - 17 REGULATION
TABLE 8D

FLOW TO CONSERVATION AREA ACRE FEET 13 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0.	14876.	3430.	0	0	0	0	23897.	7505.	0	49708.
1965	0	0	12606.	12152.	0	0	20727.	17349.	20994.	42771.	4040.	0	130639.
1966	0	0	8013.	12667.	0	10244.	48868.	35103.	25649.	45432.	1061.	0	187037.
1967	0	0	1058.	9498.	0	1026.	33041.	28709.	13509.	53031.	2108.	0	141979.
1968	0	0	3687.	16222.	6796.	29423.	38491.	4261.	21743.	41297.	5151.	0	167070.
1969	0	0	18597.	16488.	2189.	14249.	8259.	14705.	3183.	26307.	24458.	13716.	142150.
1970	13362.	36862.	45076.	18905.	1868.	22476.	29891.	24073.	4378.	14795.	0	0	211687.
1971	0	0	0	0	0	3.	15594.	4251.	33831.	51288.	24072.	0	129039.
1972	0	0	0	19389.	11225.	20187.	0	0	0	0	0	0	50801.
1973	0	0	0	14142.	0	0	22057.	42239.	30646.	14524.	0	0	123609.
AVE.	1215.	3351.	8094.	12213.	2319.	8874.	19721.	15517.	13994.	28486.	6218.	1247.	121247.

FLOW TO CONSERVATION AREA ACRE FEET 13 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	9736.	2640.	592.	0	0	0	24624.	9639.	0.	47232.
1965	0	0	12665.	10628.	0	0	12207.	6523.	16074.	39100.	2973.	0	100169.
1966	0	0	6329.	9402.	0	6329.	30981.	18589.	21231.	45468.	1859.	0	140188.
1967	0	0	5.	7404.	0	611.	15913.	18521.	10786.	47321.	1846.	0	102407.
1968	0	0	2864.	12416.	6355.	18263.	22790.	0	18314.	43553.	615.	0	125170.
1969	0	0	8933.	13076.	3139.	9004.	2.	6094.	1260.	25107.	12498.	10555.	89669.
1970	13521.	33519.	29228.	15278.	1435.	14048.	17552.	11292.	1915.	15858.	0	0	153645.
1971	0	0	0	0	0	0	8295.	2034.	32691.	42247.	18333.	0	103599.
1972	0	0	0	13336.	10092.	11726.	0	0	0	0	0	0	35154.
1973	0	0	0	8547.	0	0	12910.	31136.	24887.	14215.	0	0	91695.
AVE.	1229.	3047.	5457.	9075.	2151.	5507.	10968.	8563.	11560.	27045.	4342.	960.	89903.

13 - 16 REGULATION
TABLE 8E

PUMPING TO EAST AREA ACRE FEET 12 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16202.	170.	0	17194.	9225.	929.	8300.	22845.	12666.	5429.	6116.	99531.
1964	29781.	15987.	2511.	8490.	0	15670.	15723.	21974.	36476.	45059.	13470.	15391.	220530.
1965	0	14001.	802.	0	0	27833.	41989.	36874.	42924.	48375.	4819.	2010.	219626.
1966	24243.	12793.	4231.	5894.	0	20443.	48504.	64255.	56743.	48088.	3435.	4370.	293000.
1967	2384.	14858.	3322.	0	0	16291.	48112.	58099.	40970.	59711.	3113.	11219.	258080.
1968	2408.	13583.	4526.	0	0	15909.	40071.	37040.	60655.	60269.	13931.	0	248393.
1969	15006.	9849.	13783.	3544.	0	27560.	[illegible]	53258.	36511.	40861.	32539.	24085.	299093.
1970	30401.	11442.	20701.	0	3136.	24712.	[illegible]	43431.	32779.	23004.	225.	0	232580.
1971	1733.	4455.	601.	0	10962.	28528.	54475.	39194.	64551.	63113.	24902.	3081.	295596.
1972	4912.	11185.	5659.	7855.	0	26795.	20594.	19151.	16670.	3200.	7525.	2385.	125930.
1973	18034.	5895.	7376.	0	3393.	26524.	44287.	68860.	44920.	16845.	0	9328.	245461.
AVE.	11760.	11841.	5789.	2344.	3153.	21772.	36321.	40949.	41459.	38290.	[illegible]	7089.	230711.

PUMPING TO EAST AREA ACRE FEET 12 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16202.	170.	0	18675.	9225.	929.	8300.	22845.	12666.	5429.	6116.	101012.
1964	29781.	15987.	2511.	9156.	0	15741.	16365.	21974.	36476.	46841.	14965.	17670.	227464.
1965	0	14001.	802.	0	0	30409.	44021.	34498.	39901.	49563.	4819.	2010.	220024
1966	24243.	12793.	3776.	4865.	0	22226.	49274.	67128.	54367.	43930.	3435.	4370.	[illegible]
1967	2384.	14858.	1978.	0	0	16885.	48526.	62748.	40970.	58523.	3113.	11219.	[illegible]
1968	2408.	14771.	4526.	0	0	15909.	41450.	37040.	58279.	54923.	13502.	0	242808.
1969	15006.	9849.	11532.	3544.	0	28655.	43146.	51555.	37572.	41455.	27229.	26051.	295794.
1970	30448.	9843.	17731.	0	2376.	26508.	45718.	43431.	33373.	23004.	225.	0	232657.
1971	1733.	4455.	601.	0	10962.	32367.	56922.	40382.	57423.	64301.	23754.	3081.	295981.
1972	4912.	11185.	4798.	7770.	0	27829.	20594.	19151.	16670.	3200.	7525.	2385.	126017.
1973	18034.	5895.	7376.	0	3471.	27118.	47148.	68860.	46692.	16845.	0	9328.	250766.
AVE.	11764.	11803.	5073.	2303.	3226.	23007.	37645.	41370.	40415.	37750.	9454.	7475.	[illegible]

12 - 17 REGULATION
TABLE 9

PUMPING TO EAST AREA ACRE FEET 12 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16004.	170.	0	18394.	9225.	929.	8160.	21396.	12391.	5231.	5720.	98073.
1964	28304.	15531.	2511.	9312.	0	14622.	13658.	20786.	34628.	32854.	12426.	13826.	198459.
1965	297.	17440.	2109.	0	0	27356.	29140.	34272.	39994.	44512.	4621.	2010.	201750.
1966	23031.	16026.	5934.	7174.	4657.	17533.	15068.	60471.	53056.	42946.	3435.	4370.	253701.
1967	2384.	14066.	3322.	0	0	15499.	31165.	57277.	37103.	49999.	3113.	10387.	224317.
1968	2408.	14104.	6219.	0	0	14383.	23105.	34244.	54913.	43176.	15010.	0	207562.
1969	14412.	9453.	27168.	3346.	0	26033.	30829.	49454.	33945.	31019.	34234.	22982.	282875.
1970	32597.	11442.	19099.	0	4720.	24055.	20808.	41338.	32114.	19200.	225.	0	205599.
1971	1733.	4103.	601.	0	11754.	29033.	42851.	36951.	57966.	53965.	23140.	2883.	264979.
1972	4714.	10801.	5263.	17879.	0	27288.	19166.	18018.	15680.	3002.	7327.	2385.	131523.
1973	17440.	5697.	7039.	0	3290.	25153.	30846.	64205.	44914.	15182.	0	8536.	222302.
AVE.	11616.	12242.	7221.	3428.	3892.	20925.	23415.	38652.	38701.	31659.	9888.	6645.	208286.

PUMPING TO EAST AREA ACRE FEET 12 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16004.	170.	0	17810.	9225.	929.	8160.	21396.	12391.	5231.	5720.	97489.
1964	28304.	15531.	2511.	9312.	0	15288.	15573.	20786.	34628.	34636.	12426.	13959.	202954.
1965	297.	17440.	1515.	0	0	29819.	43318.	33084.	38806.	38315.	4621.	2010.	209225.
1966	23031.	16026.	5934.	5653.	0	19909.	48437.	60471.	50680.	38956.	3435.	4370.	276903.
1967*	2384.	14066.	3322.	0	0	15499.	48765.	57871.	39083.	45768.	3113.	10387.	240260.
1968	2408.	14104.	6219.	0	0	16957.	39428.	34244.	53725.	39018.	13017.	0	219119.
1969	14412.	9453.	27168.	3346.	0	29361.	39764.	47078.	35054.	29435.	29132.	24968.	289171.
1970	33785.	10536.	16525.	0	2740.	27092.	42631.	41338.	32114.	13062.	56.	0	219880.
1971	1733.	4103.	601.	0	9972.	32660.	53478.	37545.	54996.	52381.	24829.	2883.	275181.
1972	4714.	10801.	5263.	15406.	0	27647.	19166.	18018.	15680.	3002.	7327.	2385.	129409.
1973	17440.	5697.	7039.	0	3273.	25747.	43752.	63611.	45498.	10537.	0	8536.	231129.
AVE.	11724.	12166.	6833.	3065.	3072.	22655.	35931.	38382.	38333.	28864.	9381.	6838.	217338.

12 - 16 REGULATION
TABLE 9A

PUMPING TO EAST AREA ACRE FEET 12 - 15 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16004.	170.	0	16006.	9225.	929.	8160.	21396.	12391.	5231.	5720.	95685.
1964	28304.	15531.	2511.	9312.	0	14622.	15088.	20786.	27508.	23744.	12426.	13557.	183390.
1965	297.	17440.	12195.	0	0	27356.	40744.	35406.	34397.	43918.	4621.	2010.	218384.
1966	23031.	16026.	8118.	7174.	2261.	18721.	48059.	60471.	46823.	40620.	3435.	4370.	279109.
1967	2384.	14066.	3322.	0	0	15499.	46692.	56683.	34636.	44059.	3113.	10387.	230843.
1968	2408.	14104.	6219.	0	0	19531.	39252.	34244.	51151.	40008.	15010.	0	221927.
1969	14412.	9453.	27168.	3346.	0	27841.	38715.	48660.	29195.	29045.	33244.	20408.	281487.
1970	32597.	29171.	19099.	0	2740.	25445.	42631.	41338.	28860.	19446.	225.	0	241553.
1971	1733.	4103.	601.	0	11160.	29033.	52419.	36951.	49452.	48817.	23140.	2883.	260291.
1972	4714.	10801.	5263.	17879.	0	27288.	19166.	18018.	15680.	3002.	7327.	2385.	131523.
1973	17440.	5697.	7039.	0	3195.	25153.	41970.	63611.	37014.	15176.	0	8536.	224831.
AVE.	11616.	13854.	8337.	3428.	3215.	21792.	35060.	38575.	34192.	29111.	9798.	6387.	215366.

PUMPING TO EAST AREA ACRE FEET 12 - 15 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16004.	170.	0	17810.	9225.	929.	8160.	21396.	12391.	5231.	5720.	97489.
1964	28304.	15531.	2511.	9312.	0	15288.	15573.	20786.	30470.	25724.	12426.	13668.	189593.
1965	297.	17440.	11601.	0	0	30130.	43318.	34086.	30635.	38909.	4621.	2010.	213046.
1966	23031.	16026.	8118.	7174.	3509.	19909.	49514.	60471.	44695.	36630.	3435.	4370.	276881.
1967	2384.	14066.	3322.	0	0	15499.	48765.	57871.	32854.	43069.	3113.	10387.	231332.
1968	2408.	14104.	6219.	0	0	19531.	39428.	34244.	50755.	36444.	13393.	0	216525.
1969	14412.	9453.	27168.	3346.	0	29361.	39764.	47098.	28237.	29831.	30779.	24968.	284417.
1970	33785.	29171.	16525.	0	2740.	26508.	42631.	41338.	26484.	15165.	225.	0	234974.
1971	1733.	4103.	601.	0	11160.	32038.	53607.	38139.	47076.	47827.	22596.	2883.	261763.
1972	4714.	10801.	5263.	17879.	0	28330.	19166.	18018.	15680.	3002.	7327.	2385.	132565.
1973	17440.	5697.	7039.	0	3273.	25747.	43752.	63611.	34638.	10071.	0	8536.	219804.
AVE.	11724.	13854.	8049.	3428.	3499.	22906.	36041.	38529.	32993.	27188.	9377.	6811.	214399.

12 - 15 REGULATION
TABLE 9B

PUMPING TO EAST AREA ACRE FEET 12 - 14 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	15604.	170.	0	14745.	9225.	929.	7673.	19727.	11904.	5033.	5324.	90787.
1964	26324.	14561.	2427.	5536.	0	5738.	9965.	14983.	22612.	21503.	11700.	15238.	150587.
1965	297.	15428.	10848.	0	0	22833.	18068.	29080.	32197.	33371.	4423.	2010.	168555.
1966	21224.	14951.	8118.	6976.	5259.	5017.	10759.	41507.	37683.	30100.	3257.	4217.	189068.
1967	2384.	12935.	3322.	0	0	11714.	25289.	36299.	31468.	27172.	3113.	9397.	163093.
1968	2408.	12957.	6188.	0	0	3728.	10456.	29781.	45386.	30961.	14812.	0	156677.
1969	13797.	8956.	24594.	3148.	0	5496.	22373.	36424.	26473.	21673.	29126.	19356.	221415.
1970	30359.	8383.	4712.	0	2344.	306[illegible]	22497.	27692.	27473.	14436.	225.	0	141189.
1971	1733.	3707.	601.	0	10825.	26310.	33270.	30714.	40802.	33670.	15280.	2685.	199596.
1972	4352.	10159.	4716.	9128.	0	4122.	17432.	16434.	14387.	2804.	6935.	2349.	92818.
1973	16662.	5499.	6445.	0	2932.	12764.	25829.	32947.	29841.	12319.	0	7744.	152981.
AVE.	10908.	11195.	6558.	2253.	3282.	10001.	18806.	27594.	29822.	21810.	85[illegible]7.	6211.	156979.

PUMPING TO EAST AREA ACRE FEET 12 - 14 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	15604.	170.	0	16539.	9225.	929.	7673.	19727.	11904.	5033.	5324.	92581.
1964	26324.	14561.	2511.	5536.	0	5738.	9965.	15169.	23800.	19523.	10908.	15872.	149906.
1965	297.	15428.	10848.	0	0	23117.	20115.	29080.	31009.	31086.	4423.	2010.	167413.
1966	21224.	14951.	8118.	6976.	6023.	6700.	10429.	41776.	39315.	28714.	3257.	4217.	191700.
1967	2384.	12935.	3322.	0	0	14090.	27467.	37487.	30280.	28494.	3113.	9397.	168970.
1968	2408.	12957.	6188.	0	863.	3728.	9090.	30945.	44211.	28744.	13195.	0	152329.
1969	13797.	8956.	24594.	3148.	0	8195.	34016.	36820.	27534.	20479.	26712.	23520.	227771.
1970	31547.	23827.	17652.	0	2344.	889.	22148.	27692.	25097.	12223.	225.	0	163644.
1971	1733.	3707.	601.	0	10825.	29452.	38286.	28805.	40804.	32878.	14900.	2685.	204676.
1972	4352.	10159.	4716.	9375.	0	5447.	17432.	16434.	14387.	2804.	6935.	2349.	94391.
1973	16662.	5499.	6445.	0	2950.	17627.	28007.	33385.	27564.	8279.	0	7744.	154161.
AVE.	11016.	12599.	7742.	2276.	3595.	11292.	19808.	27752.	29430.	20466.	8064.	6647.	160685.

12 - 14 REGULATION
TABLE 9C

PUMPING TO EAST AREA ACRE FEET 13 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16202.	170.	0	20770.	9225.	929.	8300.	22845.	12666.	5429.	6116.	103107.
1964	29781.	15987.	972.	4980.	95.	19271.	16365.	21974.	36476.	37545.	13470.	15391.	212306.
1965	0	14001.	515.	0	0	28059.	46146.	36820.	42924.	47781.	4819.	2010.	223075.
1966	24243.	12793.	3261.	931.	7918.	21037.	71539.	67128.	56743.	46306.	3435.	4370.	319705.
1967	2384.	14858.	1752.	0	836.	16885.	54880.	60681.	40970.	53177.	3113.	11219.	260755.
1968	2408.	13583.	4526.	0	10399.	38854.	57486.	37040.	60655.	46013.	15119.	0	286082.
1969	15006.	9849.	13783.	1135.	8599.	28128.	43146.	52149.	36949.	37662.	32539.	21115.	300059.
1970	30401.	11442.	20701.	0	17141.	37862.	48688.	43431.	32779.	19981.	225.	0	262650.
1971	1733.	4455.	601.	0	10962.	29249.	56129.	39788.	64551.	61062.	24639.	3081.	296249.
1972	4912.	11185.	5659.	7770.	14692.	40449.	20594.	19151.	16670.	3200.	7525.	2385.	154191.
1973	18034.	5895.	5419.	0	3506.	28306.	49524.	72424.	46692.	15081.	0	9328.	254209.
AVE.	11760.	11841.	5215.	1347.	8629.	27030.	42311.	41717.	41660.	34588.	10029.	6819.	242944.

PUMPING TO EAST AREA ACRE FEET 13 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16202.	170.	0	20770.	9225.	929.	8300.	22845.	12666.	5429.	6116.	103107.
1964	29781.	15987.	972.	5504.	95.	19679.	16365.	21974.	36476.	39921.	13470.	15523.	215747.
1965	0	14001.	515.	0	0	31029.	47928.	35092.	40548.	41584.	4819.	2010.	217525.
1966	24243.	12793.	2806.	931.	7918.	21632.	73462.	67128.	52438.	42317.	3435.	4370.	313472.
1967	2384.	14858.	1752.	0	836.	16885.	53197.	60681.	40970.	53771.	3113.	11219.	259666.
1968	2408.	13583.	4526.	0	11229.	38854.	57486.	37040.	55406.	45419.	13337.	0	279287.
1969	15006.	9849.	13300.	1053.	8829.	29910.	43740.	50981.	38058.	32910.	30149.	24897.	298681.
1970	29260.	10536.	17731.	0	18329.	40287.	48688.	46124.	33373.	10542.	225.	0	255095.
1971	1733.	4455.	601.	0	10962.	32228.	58110.	40976.	60987.	54528.	24095.	3081.	291756.
1972	4912.	10631.	4798.	7770.	13674.	42683.	20594.	19151.	16670.	3200.	7525.	2385.	153991.
1973	18034.	5895.	6013.	0	3506.	29341.	50118.	69454.	46692.	9840.	0	9328.	248222.
AVE.	11656.	11708.	4835.	1387.	8741.	28341.	42783.	41536.	40406.	31518.	9600.	7175.	239686.

13 - 16 REGULATION
TABLE 9E

PUMPING TO EAST AREA   ACRE FEET   13 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16004.	170.	0	18988.	9225.	929.	8160.	21396.	12391.	5231.	5720.	98667.
1964	28304.	15531.	972.	4980.	0	15216.	13658.	20786.	31064.	27704.	12426.	14262.	184904.
1965	297.	17440.	2416.	0	0	26987.	40287.	35080.	40588.	44512.	4621.	2010.	214238.
1966	23031.	16026.	4944.	931.	7195.	18721.	56535.	60471.	52462.	42340.	3435.	4370.	290462.
1967	2384.	14066.	3322.	0	0	14905.	49395.	56683.	37804.	48613.	3113.	10387.	240673.
1968	2408.	14104.	6215.	0	1891.	31834.	43736.	34244.	53131.	43176.	15010.	0	245750.
1969	14412.	9453.	22540.	1135.	3320.	33321.	38576.	47472.	32046.	31019.	35432.	22982.	291709.
1970	32597.	11442.	19099.	0	11795.	32005.	43505.	41338.	30048.	18967.	225.	0	241021.
1971	1733.	4103.	601.	0	9972.	28843.	47864.	34575.	56580.	53965.	23140.	2883.	264258.
1972	4714.	10801.	5263.	7176.	3526.	38802.	19166.	18018.	15680.	3002.	7327.	2385.	135860.
1973	17440.	5697.	5677.	0	3290.	24559.	40746.	64205.	44320.	15182.	0	8536.	229652.
AVE.	11616.	12242.	6475.	1293.	5453.	24947.	35854.	38276.	37738.	30988.	9997.	6685.	221563.

PUMPING TO EAST AREA   ACRE FEET   13 - 16 REGULATION   WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	453.	16004.	170.	0	18988.	9225.	929.	8160.	21396.	12391.	5231.	5720.	98667.
1964	28304.	15531.	1036.	1683.	0	18701.	13351.	20786.	34628.	37002.	10446.	17763.	199232.
1965	297.	17440.	515.	0	0	31613.	31122.	25869.	39077.	41453.	3564.	2010.	192959.
1966	23031.	16026.	1449.	931.	7195.	19909.	36472.	45043.	52941.	42485.	3435.	4370.	253288.
1967	2384.	14066.	3322.	0	0	15499.	36594.	47536.	41261.	40156.	3113.	10387.	214320.
1968	2408.	14104.	4703.	0	863.	22105.	25461.	29589.	58477.	45021.	5990.	0	208720.
1969	14412.	9453.	15472.	939.	778.	32084.	30789.	42940.	37444.	29847.	21905.	24968.	261029.
1970	33785.	4170.	1556.	0	8627.	26803.	33407.	26752.	33896.	20729.	56.	0	189780.
1971	1733.	4103.	601.	0	9972.	32900.	48191.	35169.	58758.	46909.	15002.	2883.	256220.
1972	4714.	10801.	4958.	3297.	0	34012.	17662.	18018.	15680.	3002.	7327.	2385.	121855.
1973	17440.	5697.	5677.	0	3290.	27376.	38766.	52721.	40445.	14687.	0	8536.	214636.
AVE.	11724.	11581.	3587.	623.	4519.	24566.	28431.	32053.	39455.	30335.	6915.	7184.	200973.

INFLOW TO WEST AREA IN CFS 12 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2164.	0	0	0	105.	0	0	300.	2569.
1964	273.	28.	0	344.	498.	2024.	0	600.	1357.	2400.	1906.	1618.	11048.
1965	150.	2527.	1834.	0	0	3550.	2307.	2179.	3178.	2929.	537.	0	19191.
1966	0	0	0	0	2073.	316.	0	0	2968.	3163.	99.	0	8619.
1967	0	300.	0	0	422.	637.	0	1200.	2400.	4479.	319.	0	9757.
1968	0	0	0	0	0	0	0	0	3943.	3900.	2156.	0	9999.
1969	0	0	0	0	0	500.	300.	5560.	1452.	1800.	6726.	0	16338.
1970	0	0	0	0	300.	0	0	0	1193.	0	0	0	1493.
1971	0	0	0	0	1315.	3946.	2399.	2638.	8958.	3900.	835.	0	23991.
1972	0	0	94.	0	0	0	0	599.	537.	0	0	0	1230.
1973	90.	0	0	0	483.	1343.	5211.	5240.	2881.	0	0	164.	15412.
AVE.	47.	260.	175.	31.	660.	1120.	929.	1638.	2634.	2052.	1143.	189.	10877.

INFLOW TO WEST AREA IN CFS 12 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2312.	0	0	0	105.	0	0	300.	2717.
1964	273.	28.	0	680.	498.	2060.	324.	600.	1357.	2880.	2554.	2288.	13542.
1965	150.	2527.	300.	0	0	3550.	1918.	979.	2278.	300.	537.	0	12539.
1966	0	0	10.	0	2073.	1516.	0	0	1768.	1063.	99.	0	6529.
1967	0	300.	0	0	422.	1237.	131.	2100.	2400.	1529.	319.	116.	8554.
1968	0	600.	0	0	648.	0	0	0	2400.	1200.	1939.	0	6787.
1969	0	0	0	0	116.	2000.	1090.	4662.	1988.	2100.	2544.	993.	15493.
1970	600.	0	0	0	1200.	0	0	0	1266.	0	0	0	3066.
1971	0	0	0	0	1315.	5400.	3542.	3167.	5058.	1500.	255.	0	20237.
1972	0	0	94.	0	0	0	0	599.	537.	0	0	0	1230.
1973	90.	0	0	0	483.	1553.	5456.	5240.	3181.	0	0	164.	16167.
AVE.	101.	314.	37.	62.	824.	1574.	1133.	1577.	2031.	961.	750.	351.	9715.

12 - 17 REGULATION
TABLE 10

INFLOW TO WEST AREA IN CFS — 12 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1800.	0	0	0	283.	0	0	300.	2383.
1964	719.	258.	0	0	498.	2089.	967.	600.	1949.	5050.	2554.	2288.	16972.
1965	0	1090.	300.	0	0	3586.	1056.	1112.	2258.	300.	537.	0	10239.
1966	0	0	0	0	2073.	1616.	0	0	1716.	1500.	99.	0	7004.
1967	0	300.	0	0	422.	1337.	231.	2010.	2241.	1529.	319.	316.	8705.
1968	0	316.	0	0	635.	0	0	0	2700.	3300.	1339.	0	8290.
1969	0	0	0	0	116.	2115.	1002.	4401.	1767.	3116.	2379.	1003.	15899.
1970	600.	0	0	0	1200.	0	0	0	1066.	1827.	0	0	4693.
1971	0	0	0	0	562.	4346.	4107.	2859.	5400.	1636.	388.	0	19298.
1972	0	0	194.	0	0	3.	0	810.	737.	0	0	0	1744.
1973	190.	0	19.	0	483.	1584.	5829.	5181.	2837.	540.	0	264.	16927.
AVE.	137.	179.	47.	0	708.	1516.	1199.	1543.	2087.	1709.	692.	379.	10196.

INFLOW TO WEST AREA IN CFS — 12 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2095.	0	0	0	283.	0	0	300.	2678.
1964	719.	258.	0	0	498.	1753.	0	600.	1949.	5050.	2554.	2221.	15602.
1965	0	1090.	1834.	0	0	3586.	746.	1712.	3158.	3430.	537.	0	16093.
1966	0	0	0	0	2073.	416.	0	0	2916.	3515.	99.	0	9019.
1967	0	300.	0	0	422.	737.	0	1258.	2541.	4266.	319.	0	9843.
1968	0	0	0	0	0	0	0	0	3675.	5400.	2346.	0	11421.
1969	0	0	0	0	0	615.	300.	5601.	1207.	5216.	3656.	0	16595.
1970	0	0	0	0	300.	0	0	0	1366.	5001.	85.	0	6752.
1971	0	0	0	0	1315.	2632.	2229.	2559.	7200.	3736.	835.	0	20506.
1972	0	0	194.	0	0	0	0	810.	737.	0	0	0	1741.
1973	190.	0	19.	0	483.	1284.	4311.	5481.	3137.	2886.	0	264.	18055.
AVE.	83.	150.	186.	0	653.	1002.	690.	1638.	2561.	3500.	948.	253.	11664.

12 - 16 REGULATION
TABLE 10A

INFLOW TO WEST AREA IN CFS 12 - 15 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2406.	0	0	0	283.	0	0	300.	2989.
1964	719.	258.	0	0	498.	2089.	245.	600.	4127.	6296.	2554.	2424.	19810.
1965	0	300.	0	0	0	3586.	456.	539.	2100.	600.	537.	0	8118.
1966	0	0	0	0	2073.	1616.	0	0	2100.	1500.	99.	0	7388.
1967	0	300.	0	0	422.	1337.	231.	2010.	3346.	629.	319.	316.	8910.
1968	0	316.	0	0	852.	0	0	0	2400.	3600.	1339.	0	8507.
1969	0	0	0	0	116.	1815.	1274.	4605.	4166.	2813.	1579.	1003.	17371.
1970	600.	0	0	0	1200.	0	0	0	1800.	1285.	0	0	4885.
1971	0	0	0	0	862.	4346.	2764.	2859.	6300.	1636.	388.	0	19155.
1972	0	0	194.	0	0	3.	0	810.	737.	0	0	0	1744.
1973	190.	0	19.	0	483.	1584.	5211.	5190.	3600.	543.	0	264.	17084.
AVE.	137.	107.	19.	0	810.	1489.	926.	1510.	2814.	1718.	620.	392.	10542.

INFLOW TO WEST AREA IN CFS 12 - 15 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2095.	0	0	0	283.	0	0	300.	2678.
1964	719.	258.	0	0	498.	1753.	0	600.	3531.	6296.	2554.	2368.	18577.
1965	0	1090.	300.	0	0	3586.	456.	1206.	3300.	3130.	537.	0	13605.
1966	0	0	0	0	2073.	416.	0	0	3300.	3515.	99.	0	9403.
1967	0	300.	0	0	422.	737.	0	1258.	4246.	3329.	319.	0	10611.
1968	0	0	0	0	0	0	0	0	3900.	5400.	2156.	0	11456.
1969	0	0	0	0	0	615.	300.	5591.	4650.	3716.	2824.	0	17696.
1970	0	0	0	0	300.	0	0	0	3000.	3747.	0	0	7047.
1971	0	0	0	0	862.	2840.	2464.	2323.	7500.	3736.	663.	0	20388.
1972	0	0	194.	0	0	0	0	810.	737.	0	0	0	1741.
1973	190.	0	19.	0	483.	1284.	4311.	5481.	4800.	2331.	0	264.	19163.
AVE.	83.	150.	47.	0	612.	1021.	685.	1570.	3568.	3200.	832.	267.	12033.

12 - 15 REGULATION
TABLE 10B

INFLOW TO WEST AREA IN CFS — 12 - 14 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	2442.	0	0	80.	521.	46.	0	300.	3389.
1964	1334.	748.	42.	1580.	498.	2960.	2386.	2278.	5096.	4496.	1054.	376.	22848.
1965	0	300.	0	0	0	3791.	623.	588.	1680.	300.	537.	0	7819.
1966	0	0	0	0	2073.	1800.	0	0	1917.	1500.	99.	0	7389.
1967	0	300.	0	0	422.	1437.	300.	1786.	3646.	929.	319.	516.	9655.
1968	0	195.	0	0	635.	0	0	0	2700.	3300.	1339.	0	8169.
1969	0	0	0	0	116.	2347.	830.	4659.	3822.	2816.	1545.	1003.	17138.
1970	600.	0	0	0	1200.	0	0	0	1800.	1285.	0	0	4885.
1971	0	0	0	0	547.	6175.	3636.	3535.	3600.	1636.	388.	0	19517.
1972	0	0	294.	0	0	669.	0	1010.	975.	0	98.	0	3046.
1973	327.	0	119.	0	483.	3568.	5614.	2400.	3310.	291.	0	300.	16412.
AVE.	206.	140.	41.	144.	765.	2068.	1217.	1485.	2642.	1509.	489.	227.	10933.

INFLOW TO WEST AREA IN CFS — 12 - 14 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1836.	0	0	80.	521.	46.	0	300.	2783.
1964	1334.	748.	0	1580.	498.	2960.	2386.	2184.	4841.	6296.	2554.	56.	25437.
1965	0	0	0	0	0	3791.	0	588.	2280.	3300.	537.	0	10496.
1966	0	0	0	0	2073.	516.	0	0	2926.	3815.	99.	0	9429.
1967	0	300.	0	0	422.	537.	0	1186.	4246.	3366.	319.	0	10376.
1968	0	0	0	0	0	0	0	0	3900.	5400.	2156.	0	11456.
1969	0	0	0	0	0	847.	0	5859.	3286.	4819.	2764.	0	17575.
1970	0	0	0	0	300.	0	0	0	3000.	3747.	0	0	7047.
1971	0	0	0	0	547.	3688.	2693.	4499.	4800.	3736.	663.	0	20626.
1972	0	0	294.	0	0	0	0	1010.	975.	0	98.	0	2377.
1973	327.	0	119.	0	483.	3568.	5014.	3000.	3910.	2331.	0	300.	19052.
AVE.	151.	95.	38.	144.	560.	1446.	918.	1673.	3153.	3351.	835.	60.	12423.

12 - 14 REGULATION
TABLE 10C

INFLOW TO WEST AREA IN CFS 13 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1333.	0	0	0	105.	0	0	300.	1738.
1964	273.	28.	777.	1580.	498.	241.	0	600.	1357.	4995.	2554.	2288.	15191.
1965	150.	2527.	445.	0	0	3445.	1318.	1006.	2278.	600.	537.	0	12306.
1966	0	0	500.	0	1708.	1516.	0	0	1768.	1500.	99.	0	17091.
1967	0	300.	0	0	0	1537.	131.	2244.	2400.	1229.	319.	116.	8276.
1968	0	600.	0	0	648.	0	0	0	2400.	3600.	1339.	0	8587.
1969	0	0	0	0	116.	1811.	560.	5260.	1767.	2816.	2544.	993.	15867.
1970	600.	0	0	0	1200.	0	0	0	1266.	1527.	0	0	4593.
1971	0	0	0	0	1315.	5313.	2707.	2938.	5058.	1636.	388.	0	19355.
1972	0	0	94.	0	0	0	0	599.	537.	0	0	0	1230.
1973	90.	0	988.	0	474.	743.	5211.	5090.	2881.	891.	0	164.	16532.
AVE.	101.	314.	255.	144.	663.	1328.	902.	1612.	1983.	1709.	707.	351.	10070.

INFLOW TO WEST AREA IN CFS 13 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1333.	0	0	0	105.	0	0	300.	1738.
1964	273.	28.	777.	1580.	498.	35.	0	600.	1357.	4995.	2554.	2221.	14918.
1965	150.	2527.	1979.	0	0	3445.	418.	1879.	3478.	3730.	537.	0	18143.
1966	0	0	490.	0	1708.	616.	0	0	3942.	3515.	99.	0	10370.
1967	0	300.	0	0	0	937.	0	2544.	2400.	4229.	319.	0	10729.
1968	0	600.	0	0	0	0	0	0	5438.	5400.	2239.	0	13677.
1969	0	0	0	0	0	911.	0	5947.	1207.	5216.	3751.	583.	17615.
1970	600.	0	0	0	600.	0	0	358.	1193.	6294.	0	0	9045.
1971	0	0	0	0	1315.	3600.	1799.	2338.	7458.	3736.	663.	0	20909.
1972	0	28.	94.	0	0	0	0	599.	537.	0	0	0	1510.
1973	90.	0	688.	0	474.	220.	3964.	6781.	2881.	3538.	0	164.	18800.
AVE.	101.	340.	366.	144.	539.	888.	562.	1913.	2727.	3696.	924.	297.	12496.

13 - 17 REGULATION
TABLE 10D

INFLOW TO WEST AREA IN CFS 13 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1500.	0	0	0	283.	0	0	300.	2083.
1964	719.	258.	777.	1580.	498.	1789.	967.	600.	3231.	6296.	2554.	2068.	21337.
1965	0	300.	145.	0	0	3586.	728.	484.	1750.	300.	537.	0	7830.
1966	0	0	500.	0	2073.	1616.	0	0	1786.	1500.	99.	0	7574.
1967	0	300.	0	0	422.	1337.	231.	1913.	3187.	929.	319.	316.	8954.
1968	0	316.	0	0	635.	0	0	0	2700.	3300.	1339.	0	8290.
1969	0	0	0	0	116.	1726.	1224.	4760.	2726.	3116.	1774.	1003.	16445.
1970	600.	0	0	0	1200.	0	0	0	1366.	1527.	0	0	4693.
1971	0	0	0	0	1315.	5313.	3101.	3867.	3900.	1636.	388.	0	19520.
1972	0	0	194.	0	0	3.	0	810.	737.	0	0	0	1744.
1973	190.	0	707.	0	483.	1694.	5829.	4340.	2963.	540.	0	264.	17010.
AVE.	137.	107.	211.	144.	749.	1551.	1098.	1525.	2239.	1740.	637.	359.	10498.

INFLOW TO WEST AREA IN CFS 13 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	1500.	0	0	0	283.	0	0	0	1783.
1964	719.	0	745.	1580.	498.	0	1122.	600.	0	0	2554.	0	7818.
1965	0	0	1979.	0	0	0	4957.	5136.	0	0	1071.	0	13143.
1966	0	0	3255.	1450.	2073.	0	9279.	8691.	0	0	99.	0	24847.
1967	0	0	0	0	422.	0	6831.	6533.	0	0	319.	0	14105.
1968	0	0	766.	0	4556.	0	7991.	3423.	0	0	5895.	0	22631.
1969	0	0	4314.	203.	550.	0	5157.	7056.	0	0	7606.	0	24886.
1970	0	0	6900.	2084.	2400.	0	6600.	6967.	0	0	85.	0	25036.
1971	0	0	0	0	1315.	0	4236.	3567.	0	0	5098.	0	14216.
1972	0	0	348.	2153.	5590.	0	817.	810.	0	0	0	0	9718.
1973	0	0	707.	0	483.	0	5829.	8960.	0	0	0	0	15979.
AVE.	65.	0	1729.	679.	1762.	0	4802.	4704.	26.	0	2066.	0	15833.

13 - 16 REGULATION
TABLE 10E

OUTFLOW FROM WEST AREA ACRE FEET 12 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	5.	0.	0	0	0	0	0.	3134.	1.	0.	3141.
1966	1366.	1756.	115.	0.	0	168.	3851.	0	0	2157.	0	0	9413.
1967	0	1.	97.	0.	0	0	0	0	0	3487.	0	0	3584.
1968	3.	100.	181.	4.	13.	2836.	7422.	0	0	311.	615.	1645.	13130.
1969	609.	363.	293.	7.	0.	1.	0	0	0	625.	2556.	5140.	9594.
1970	3774.	2844.	2658.	477.	4.	190.	569.	0	0	1268.	0	0	11784.
1971	0	0	0	0	0	0	0	0	0	3526.	3592.	1662.	8781.
1972	1462.	565.	50.	18.	15.	0.	0	0	0	0	0	0	2110.
1973	0	0	0	0	0	0	0	0	2850.	1612.	0	0	4462.
AVE.	656.	512.	309.	46.	3.	290.	1077.	0	259.	1466.	615.	768.	6000.

OUTFLOW FROM WEST AREA ACRE FEET 12 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	1050.	2.	0	1052.
1966	0	4908.	1991.	25.	0	511.	7117.	0	0	0	0	0	14552.
1967	0	0.	1862.	21.	0	219.	3.	0	0	4.	0	0	2109.
1968	0	586.	2357.	88.	66.	4721.	9114.	0	0	0.	523.	0	17453.
1969	0.	3621.	3924.	177.	13.	184.	0	0	0	0	524.	1.	8444.
1970	3337.	6177.	6100.	1977.	17.	685.	707.	0	0	0	0	0	18999.
1971	0	0	0	0	0	0	0	0	0	1577.	4911.	0	6488.
1972	1049.	3537.	1772.	521.	404.	1049.	0	0	0	0	0	0	8331.
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
AVE.	399.	1712.	1637.	255.	45.	670.	1540.	0	0	239.	542.	0.	7039.

12 - 17 REGULATION
TABLE 11

OUTFLOW FROM WEST AREA   ACRE FEET   12 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	34.	0.	0	0	0	0	0.	3753.	1.	0.	3788.
1966	1205.	1744.	113.	0.	0	173.	4046.	0	0	3133.	0.	0	10412.
1967	0	1.	103.	0.	0	0	0	0	0	3481.	0	0	3585.
1968	151.	156.	152.	3.	10.	2753.	7327.	0	0	5082.	934.	1652.	18218.
1969	756.	360.	290.	7.	0.	12.	0	0	0	1896.	2577.	5115.	11013.
1970	3759.	2775.	2658.	477.	4.	190.	569.	0	0	1910.	0.	0	12342.
1971	0	0	9.	0	0	0	0	0	0	4228.	3640.	1653.	9530.
1972	1453.	555.	48.	20.	17.	0.	0	0	0	0	0	0	2094.
1973	0	0	0	0	0	0	0	0	3265.	2986.	0	0	6250.
AVE.	666.	508.	310.	46.	3.	284.	1086.	0	297.	2406.	650.	765.	7021.

OUTFLOW FROM WEST AREA   ACRE FEET   12 - 16 REGULATION   WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0.	0	0	0	0	0	2636.	3.	0	2639.
1966	0	5124.	1987.	25.	0	594.	7171.	0	0	6.	0	0	14906.
1967	0	4.	2049.	26.	0	266.	384.	0	0	4.	0	0	2732.
1968	0	779.	2369.	89.	67.	4729.	9122.	0	0	4927.	526.	0	22609.
1969	0.	3617.	3919.	177.	13.	200.	0	0	0	0	1044.	0.	8969.
1970	3317.	5956.	6108.	1981.	17.	686.	707.	0	0	3.	0	0	18775.
1971	0	0	722.	3.	0	0	0	0	0	1048.	4894.	0	6666.
1972	1044.	3520.	1758.	541.	425.	1077.	0	0	0	0	0	0	8365.
1973	0	0	0	0	0	0	0	0	0	3.	0	0	3.
AVE.	396.	1727.	1719.	258.	47.	687.	1580.	0	0	784.	588.	0.	7788.

12 - 16 REGULATION
TABLE 11A

OUTFLOW FROM WEST AREA   ACRE FEET   12 - 15 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	616.	522.	195.	0.	0	0	0	0	0	3751.	1.	0.	5086.
1966	1368.	1760.	115.	0.	0	174.	4058.	0	0	4101.	0.	0	11578.
1967	0	1.	109.	0.	0	0	0	0	0	4758.	0	0	4868.
1968	2.	76.	134.	2.	12.	2806.	7388.	0	0	5098.	1237.	1641.	18396.
1969	606.	337.	291.	7.	0.	0.	0	0	0	3262.	5146.	5122.	14771.
1970	3765.	2780.	2661.	478.	4.	190.	569.	0	0.	2257.	0.	0	12706.
1971	0	0	9.	0	0	0	0	0	0	4212.	3628.	1647.	9497.
1972	1448.	548.	46.	19.	16.	0.	0	0	0	0	0	0	2078.
1973	0	0	0	0	0	0	0	0	3309.	3602.	0	0	6911.
AVE.	710.	548.	324.	46.	3.	288.	1092.	0	301.	2822.	910.	765.	7808.

OUTFLOW FROM WEST AREA   ACRE FEET   12 - 15 REGULATION   WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	120.	1.	0	0	0	0	0	2639.	0.	0	2761.
1966	0	4434.	1907.	24.	0	591.	7160.	0	0	1047.	0	0	15163.
1967	0	4.	2059.	27.	0	270.	384.	0	0	3199.	0	0	5943.
1968	0	390.	2262.	85.	64.	4704.	9097.	0	0	4984.	519.	0	22105.
1969	0.	3420.	3930.	178.	13.	213.	0	0	0	1057.	2705.	1.	11519.
1970	3345.	6192.	6113.	1983.	17.	687.	708.	0	0	5.	0.	0	19048.
1971	0	0	823.	3.	0	0	0	0	0	1066.	4948.	0	6840.
1972	1040.	3506.	1746.	535.	419.	1069.	0	0	0	0	0	0	8316.
1973	0	0	0	0	0	0	0	0	0	3221.	0	0	3221.
AVE.	399.	1631.	1724.	258.	47.	685.	1577.	0	0	1565.	743.	0.	8629.

12 - 15 REGULATION
TABLE 11B

OUTFLOW FROM WEST AREA ACRE FEET 12 - 14 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	949.	310.	3094.	4352.
1965	1987.	1145.	273.	1.	0	0	0	0	1.	3770.	1.	0.	7178.
1966	1355.	1716.	112.	0.	0	185.	4456.	0	0	3476.	0.	0	11300.
1967	0.	24.	112.	0.	0	0	0	0	0	5698.	0	0	5835.
1968	448.	191.	148.	3.	10.	2741.	7313.	0	0	5074.	932.	1649.	18510.
1969	754.	336.	289.	7.	0.	59.	0	0	0	2915.	4485.	5134.	13979.
1970	3774.	2844.	2658.	477.	4.	190.	569.	0	0.	2258.	0.	0	12775.
1971	0	0	9.	0	0	0	0	0	0	4204.	3623.	1428.	9264.
1972	1459.	562.	49.	23.	20.	71.	0	0	0	0	0	0	2184.
1973	0	0	0	0	0	0	0	0	3385.	3580.	0	0	6965.
AVE.	889.	620.	332.	46.	3.	295.	1122.	0	308.	2902.	850.	1028.	8395.

OUTFLOW FROM WEST AREA ACRE FEET 12 - 14 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	2233.	2246.	34.	0.	0	0	0	0	2630.	2.	0	7147.
1966	0	4928.	2015.	25.	0	683.	7247.	0	0	518.	0.	0	15416.
1967	0	196.	2167.	29.	0	242.	193.	0	0	2664.	0	0	5491.
1968	0	393.	2349.	87.	65.	4714.	9107.	0	0	4990.	520.	0	22226.
1969	0.	3605.	3905.	174.	12.	260.	0	0	0	1048.	2685.	0.	11690.
1970	3305.	5933.	6088.	1972.	16.	683.	706.	0	0	5.	0.	0	18708.
1971	0	0	823.	3.	0	0	0	0	0	1063.	4939.	0	6828.
1972	1038.	3498.	1728.	560.	445.	1104.	0	0	0	0	0	0	8374.
1973	0	0	0	0	0	0	0	0	0	3227.	0	0	3227.
AVE.	395.	1890.	1938.	262.	49.	699.	1568.	0	0	1468.	741.	0.	9010.

12 - 14 REGULATION
TABLE 11c

OUTFLOW FROM WEST AREA ACRE FEET 13 - 17 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	20.	0.	0	0	0	0	0.	4078.	1.	0.	4100.
1966	1361.	1748.	113.	0.	0	174.	4059.	0	0	3155.	0.	0	10611.
1967	0	1.	109.	0.	0	0	0	0	0	3134.	0	0	3244.
1968	2.	75.	172.	4.	12.	2817.	7401.	0	0	5111.	1241.	1645.	18480.
1969	751.	332.	286.	7.	0.	0.	0	0	0	1870.	2555.	5137.	10938.
1970	3772.	2842.	2657.	477.	4.	190.	569.	0	0	1592.	0.	0	12102.
1971	0	0	9.	0	0	0	0	0	0	4207.	3625.	1429.	9270.
1972	1460.	563.	50.	18.	15.	0.	0	0	0	0	0	0	2106.
1973	0	0	0	0	0	0	0	0	1849.	2952.	0	0	4802.
AVE.	668.	506.	311.	46.	3.	289.	1093.	0	168.	2373.	675.	747.	6877.

OUTFLOW FROM WEST AREA ACRE FEET 13 - 17 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0.	0	0	181.	773.	2540.	2649.	1.	2524.	8669.
1966	3427.	3203.	1089.	15.	0	375.	6847.	2994.	0	6.	0	1047.	19003.
1967	759.	841.	1516.	14.	0	159.	2938.	197.	0	6.	0	1053.	7482.
1968	1298.	1026.	2127.	80.	61.	4683.	9056.	6476.	0	4947.	530.	5463.	35747.
1969	2588.	1219.	2470.	76.	3.	166.	80.	0	0	0	519.	10049.	17170.
1970	4747.	4487.	4999.	1379.	9.	564.	4153.	2803.	0	0	0	692.	23833.
1971	1.	0.	421.	1.	0	21.	0.	0	2.	1064.	4943.	5108.	11563.
1972	3052.	2127.	612.	224.	235.	611.	980.	0	0	0	0	0	7841.
1973	0	0	0	0	0	0	0	2.	3590.	0	0	0	3592.
AVE.	1443.	1173.	1203.	163.	28.	598.	2203.	1204.	557.	788.	545.	2358.	12264.

13 - 17 REGULATION
TABLE 11D

OUTFLOW FROM WEST AREA ACRE FEET 13 - 16 REGULATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0.	0.
1965	1266.	693.	232.	1.	0	0	0	0	0.	3446.	1.	0.	5638.
1966	1209.	1750.	114.	0.	0	243.	5100.	0	0	3458.	0.	0	11873.
1967	0	1.	109.	0.	0	0	0	0	0	4404.	0	0	4515.
1968	150.	132.	150.	3.	10.	2748.	7322.	0	0	5079.	933.	1651.	18179.
1969	755.	359.	289.	7.	0.	0.	0	0	0	2733.	3366.	4873.	12383.
1970	3773.	2843.	2657.	477.	4.	190.	569.	0	0	1906.	0.	0	12418.
1971	0	0	9.	0	0	0	0	0	0	4226.	3638.	1653.	9525.
1972	1453.	554.	48.	20.	17.	0.	0	0	0	0	0	0	2092.
1973	0	0	0	0	0	0	0	0	3273.	2994.	0	0	6267.
AVE.	782.	576.	328.	46.	3.	289.	1181.	0	298.	2568.	722.	743.	7535.

OUTFLOW FROM WEST AREA ACRE FEET 13 - 16 REGULATION WITH TOE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	5.	0	377.	10948.	17028.	11982.	4796.	0	0	45137.
1967	0	0.	1643.	16.	0	15.	4730.	8851.	0	3695.	0	0	18950.
1968	0	0	2038.	104.	908.	8212.	16597.	16572.	531.	4.	7577.	0	52542.
1969	1037.	4377.	6187.	2521.	507.	2060.	2644.	2592.	0	0	9925.	2636.	34486.
1970	4112.	6230.	8452.	8706.	2167.	7090.	11313.	16613.	11835.	5527.	0	0	82045.
1971	0	0	281.	1.	0	0	0	0	0	0	0	0	281.
1972	0	0	215.	278.	3753.	6126.	4797.	0	0	0	0	0	15168.
1973	0	0	0	0	0	0	0	357.	0	1.	0	0	358.
AVE.	468.	964.	1710.	1057.	667.	2171.	4639.	5638.	2213.	1275.	1591.	240.	22633.

13 - 16 REGULATION
TABLE 11E

APPENDIX "A"

SEEPAGE INVESTIGATION

FOR THE

HOLEY LAND

SUMMARY AND CONCLUSIONS

Ten exploratory borings were completed in the proposed retention area. In addition 16 permeability tests were performed at 11 sites. From these borings and from falling head permeability tests, 5 hydrogeologic units were defined. The composite transmissivity for these units plus flow through the levee was estimated to be 14,259.9 GPD/foot. The flow through a levee to a boundary canal was calculated for various head differentials from 1 to 10 feet and for an incrementally increasing distance of flow from 150 feet to 177 feet using the modified Darcy equation Q = TIL. These values of seepage ranged from a maximum of 7.77 cfs per mile of levee to 0.66 cfs per mile of levee. Assuming an average head of 5 feet, the average seepage will be 3.53 cfs per mile of levee, or for the total 27.7 mile perimeter of the proposed retention area, the seepage will be 63.19 million gallons/day.

SEEPAGE INVESTIGATION FOR THE HOLEY LAND

The proposed Holey Land retention area is located in southwest Palm Beach County west of Highway 27, east of the Miami Canal and L-23 and north of L-5 (Figure 1). This area comprises approximately 29,000 acres of relatively undisturbed Everglades terrain. The only major man-made influence on this area has been its use as a practice bombing range during and after World War II, and from which it derives its name. The purpose of this investigation was to examine and define the shallow stratigraphy, to determine the water transmitting characteristics of the defined hydrogeologic units, and to quantify seepage that could occur under varying head differentials through and beneath existing and proposed levees to an outside boundary canal.

METHODS OF INVESTIGATIONS

On September 8, 1975, a preliminary site inspection was made to select areas providing ease of access and representative characteristics for relevant interpolation to the entire area of investigation. As a result of this reconnaissance it was concluded that site accessibility for drilling equipment was a major limiting factor in selecting the locations for exploratory drilling and for conducting the necessary field investigations required to meet the objectives of this study. Figure 2 shows the location of the sites selected. Figure 3 shows typical cross sections from the proposed retention area through the levee to the Miami Canal and to the L-5 Borrow Canal. The only areas sufficiently firm enough to support the drill rig were immediately adjacent to the canals. The area on the retention side of the levees was covered with dense brush and 0-6 inches of water underlain by soft plastic muck. From September 15 to September 24 ten exploratory borings were completed. Detailed lithologic logs of the earth materials encountered were made during the drilling operations. One and one-half inch inside diameter PVC pipe was set in six of these holes in order to isolate and test the permeability of a specific stratum. The results of these permeability tests were then extrapolated to areas in which the same geologic materials were encountered.

The permeability tests were conducted using a falling head method outlined by Hvorslev (1951)[1]. An open ended casing was set flush with the bottom of the hole and sealed with a packer to prevent any upward leakage of water around the outside of the casing. The water level within the casing was allowed to come to equilibrium with the surrounding water table. A slug of water was then introduced into the well and the rate of water level decline vs. time was measured. The permeability was then determined by using the following formula:

$$kvh = \frac{2\pi R}{11\ (t_2 - t_1)} \ \ln \frac{(h_1)}{h_2}$$

where,

R = radius of the well in feet.

h_1= head in feet above static conditions at time t_1 in minutes.

h_2= head in feet above static conditions at time t_2 in minutes.

The accuracy and reproducability of this type of test depends on many factors that are beyond the investigators control in the field. The values derived serve only to indicate the magnitude of the in situ permeability.

This same type of falling head test was conducted on the retention area side of the levees at three separate sites using 8 inch I.D. PVC pipe. These installations were constructed by digging an open hole and placing the 8 inch casing flush with the bottom of the hole. Muck mixed with bentonite was then backfilled tightly around the pipe to provide an effective seal. Water was then added and the change of head with respect to time recorded.

An alternate method for estimating the permeability was also employed on two of the exploratory holes in which no casing was to be installed. This method consisted of boring a hole to the desired depth, removing all cuttings and drill tools, and then adding a slug of water. The rate of change of head with respect to time is then recorded and the permeability determined from the formula:

$$k = \frac{R}{16\ DS} \quad \frac{(H_2 - H_1)}{(t_2 - t_1)} \qquad (2)$$

where,

R = radius of the hole.

D = static depth of water table.

S = shape factor coefficient.

H_1= Initial head in feet at time t_1 minutes.

H_2= Final head in feet at time t_2 in minutes.

Again, this method is only useful for estimating the magnitude of the permeability. Conceptual diagrams of all of the permeability tests have been included in the appendix.

Using the measured values for permeability determined by the above methods in the general Darcy equation for groundwater flow, the quantities of underflow can be calculated. However, the Darcy equation:

$$Q = KIA$$

was modified to:

$$Q = TIL$$

in order to include transmissivity. The transmissivities of the individual units were then summed to derive the total transmissivity of the geologic materials to a depth of 30 feet. This composite transmissivity term includes the transmissivity of the levee and fill material which overlie the muck. For purposes of calculating the seepage it was assumed that for each one foot reduction in head differential one foot of aquifer thickness having the permeability of the levee and fill material was subtracted from the composite transmissivity term. The following restraints were also assumed for mathematical simplicity:

1) The retention area will be bounded by a levee with an outside boundary canal.
2) The levee slopes will be approximately 1 vertical to 3 horizontal and the minimum distance between the canal and the impounded water will be 150 feet.
3) The maximum head differential between the water level in the canal and the retention area will be 10 feet.
4) The maximum thickness of saturated material influencing the quantity of seepage is 30 feet + 9 feet of levee and fill.
5) When calculating the quantity of seepage, engineering judgment was used to select the most representative value of permeability for each unit. In all cases a conservative figure was selected in order to overestimate rather than underestimate the total seepage.

GEOLOGY

The Holey Land is underlain by a series of limestone, sandy limestone, and clayey sands of Miocene to Holocene age topped by a layer of peaty muck ranging in thickness from 2 to 3 feet. No attempt has been made to separate the material into specific geologic units; rather the boundaries have been selected on the basis of hydrologic properties. Parker, Ferguson, Love and Others (1955)[3] compiled the most extensive description of the geology and hydrology of southeast Florida including the Holey Land area. The U.S. Army Corps of Engineers was responsible for the design of the levees and canals and published the results of their soil boring investigations in Design memorandum Part I (1954)[4]. Figures 4 and 5 are geologic cross sections for L-23 and L-5, respectively, taken as interpreted by the Corps. The boring logs completed for this investigation have been included in the appendix. Figure 6 is a cross section constructed from these borings. The agreement between the Corps of Engineers' interpretation of the subsurface structure and the District's interpretation is relatively good. Emphasis of the present investigation was focused primarily on shallower units than the Corps Boring Program. The minor discrepancies that are apparent between Figures 4 and 5 and Figure 3, are due to the District's selection of unit boundaries based on hydraulic properties and not on strictly lithologic or fossil criteria.

Generally, the shallow (<30 feet) stratigraphy can be separated into five hydrogeologic units based on composition and water transmitting characteristics.

The surface unit is the black peaty muck which varies in thickness from 2 to 3 feet. It is composed largely of organic material, plant roots and a small percentage of sand. On the retention area side of the levees the muck is exposed at the surface, on the opposite side of the levees, adjacent to the canals, the muck is overlain by 1 to 2 feet of fill material and has been compacted considerably. The permeability measured in the muck during the course of this study ($\approx 10^{-2}$ feet/minute) was much higher than expected. However, similar studies by Meyer (1971)[5] on Hoover Dike and by Klein and Sherwood (1961)[6] on Levee 30 found muck permeabilities within the same range. The measured permeability of the buried and compacted muck was 1 to 2 orders of magnitude less than the exposed muck.

Underlying the muck unit is a layer of hard siliceous limestone 2 to 4 feet in thickness. The water transmitting characteristics of this unit are moderate to poor, varying from one to two orders of magnitude less than the overlying uncompacted muck.

Below the muck and limestone units is a heterogenous zone of sands, clayey sands, and sandy limestones extending to a depth of approximately 20 to 22 feet below ground surface. The grouping of these various rock types into one unit was based on their similar water transmitting abilities. In one infiltration test a very low value of permeability at a 12 foot depth was measured. This appeared to be the result of a local lense of clay and was not indicative of an extensive bed. An average permeability of $\approx 10^{-3}$ feet/minute was used for the entire unit.

At a depth of 22-23 feet, immediately below the hetrogenous unit, a zone of high permeability was encountered in Borings Nos. 1, 7, 8, and 9. This one foot thick unit appeared to exist throughout the area of investigation. Inspection of the Corps of Engineers' cross sections does not indicate any unusual zones or lithologies at this depth, however, such a radical increase in permeability dictated that this zone be considered as a separate unit. Attempts to measure the permeability were unsuccessful due to its unusually high water transmitting ability. Field estimates placed the permeability at approximatley 10^{-1} feet/minute.

Underlying this highly permeable zone is a poorly sorted unit composed of silt and fine to medium sand. The exact thickness is unknown but the zone does extend 30 feet or more below ground level and is therefore considered the basal unit of interest. The measured permeability (10^{-5} feet/minute) is low and indicative of the unsorted composition of the unit.

The compacted levee and fill material overlying the muck are composed of material taken from the adjacent canal or borrow. As such, it is an extremely unsorted conglomerate possessing a low permeability. One open hole permeability test was conducted on the levee, resulting in a measured permeability of approximately 10^{-4} feet/minute.

SEEPAGE CALCULATIONS

Table I summarizes the field derived permeabilities used to calculate the flow through the levee. Table II is the calculated values for various head differentials of 1 to 10 feet and the calculated quantity of underflow.

The modified Darcy equation, $Q = TIL$ was used to calculate the seepage out of the retention area. The transmissivity (T) of the material is a product of the permeability and the thickness and is a measure of the quantity of water that will flow through a one foot vertical strip of an aquifer under a hydraulic gradient of one. As the head declines the saturated thickness is reduced and therefore the transmissivity is lowered. The change in transmissivity is dependent on the permeability of the unit being dewatered.

The gradient is the ratio of the vertical change in head with respect to distance. As the level of water in the retention area declines, the distance between the impounded water and the canal increases at the rate of 3 horizontal feet for each vertical foot decline. The relationship between the change in head and the change in transmissivity and gradients introduces a nonlinearity into the Darcy equation. Figure 6 summarizes this relationship in graphic form.

The depth of water that is proposed for the retention area is 3 to 4 feet. If the average water depth in the canal is 1 to 2 feet below ground surface, then an average head differential of 5 feet can be assumed. From Figure 6 it can then be seen that under normal operating conditions, 2.28 million gallons per day per mile of levee or 3.53 cfs per mile of levee will seep out of the proposed retention area. For the proposed perimeter distance of 27.7 miles, the total seepage per day would be 63.19 million gallons.

TABLE 1

TOTAL DEPTH (FEET)	HYDROGEOLOGIC UNIT	PERMEABILITY (k)	THICKNESS (m)	TRANSMISSIVITY $T = (k \times m)$
+7 to-0.5	Levee Material	1.65 GPD/FOOT^2	7	11.55 GPD/FOOT
-0.5 to 2.5	Fill Material	1.5 GPD/FOOT^2	2	3.0 GPD/FOOT
-2.5 to 6.0	Muck	762 GPD/FOOT^2	3.5	2,669.1 GPD/FOOT
-6.0 to -10	Hard Limestone	90 GPD/FOOT^2	4	360 GPD/FOOT
-10 to -22	Interbedded Sand, Limestone, and Clayey Sand	37 GPD/FOOT^2	12	444 GPD/FOOT
-22 to -23	Highly Permeable Limestone	10,771 GPD/FOOT^2	1	10,771 GPD/FOOT
-23 to -30	Poorly Sorted Silt and Fine to Medium Sand	1.18 GPD/FOOT^2	7	1.26 GPD/FOOT
				= 14,259.9 GPD/FOOT

TABLE 2

SEEPAGE CALCULATIONS FOR HEAD DIFFERENTIALS ACROSS THE LEVEE OF 1 TO 10 FEET

Q = TIL, L = 5,280

HEAD DIFFERENTIAL	GRADIENT (I)	TRANSMISSIVITY (T) GPD/FOOT	SEEPAGE Q/MILE OF LEVEE	
10	.067	1.42599×10^4	5.02×10^6 GPD	7.77 CFS
9	.059	1.42583×10^4	4.43×10^6 GPD	6.85 CFS
8	.051	1.42566×10^4	3.86×10^6 GPD	5.98 CFS
7	.044	1.42550×10^4	3.31×10^6 GPD	5.13 CFS
6	.037	1.42533×10^4	2.79×10^6 GPD	4.31 CFS
5	.030	1.42517×10^4	2.28×10^6 GPD	3.53 CFS
4	.024	1.42500×10^4	1.79×10^6 GPD	2.77 CFS
3	.018	1.42484×10^4	1.32×10^6 GPD	2.04 CFS
2	.011	1.42469×10^4	8.65×10^5 GPD	1.34 CFS
1	.006	1.42454×10^4	4.25×10^5 GPD	.657 CFS

APPENDIX

A P P E N D I X

BORING #1

Approximately 200 feet northeast of S-8 on the apron of L-5, Borrow Canal.

0 - 4 feet	Fill; silt, sand, limestone pebbles
4 - 9 feet	Top 2 feet is hard siliceous limestone underlain by unsorted silt, sand, and broken limestone fragments
9 - 10 feet	Light brown silt and sand with limestone pebbles
10 - 14 feet	Silt, fine to coarse sand
14 - 19 feet	Light brown silt, sand, and limestone fragments
19 - 24 feet	No return but probably same as above. At 22 foot depth, mud and cuttings flow back into hole, no change in drilling rate but radical increase in permeability

TOTAL DEPTH 24 feet

BORING #2

6 miles north of S-8 along the apron of the Miami Canal approximately 15 feet in from the water's edge.

0 - 1.5 feet	Fill; pebbles, sand, and silt some hard rock
1.5 - 3 feet	Wet sand and limestone pebbles, poorly sorted some hard rock
3 - 5 feet	Black plastic mud (muck), total depth 5.2 feet casing set at 5.2 feet

BORING #3

6 miles north of S-8, 10 feet north of #2.

0 - 5 feet	Same as #1
5 - 6.5 feet	Muck underlain by thin (<6 inches) dark brown sandy clay, grading into light tan silty sand
6.5 - 10 feet	Hard drilling, no return, probably siliceous limestone

Casing set in limestone at 10 foot depth

BORING #4

6 miles north of S-8, 10 feet north of Boring #2.

0 - 10	same as #1 and #2
10 - 14	fairly hard drilling, no return, probably limestone with some thin sand lenses

Total depth 14 feet, however, hole collapsed to 12 foot depth where casing was set.

BORING #5

6 miles north of S-8, 10 feet north of Boring #4.

0 - 11 feet	Same as Nos. 1 through 4
11 - 14 feet	Very easy drilling, no return but probably sand

Casing set at 15 foot total depth.

BORING #6

1 mile north of S-8 on the apron of the Miami Canal, 15 feet from the water's edge.

0 - 3 feet	Fill? sand, clay, and limestone pebbles
3 - 4 feet	Muck
4 - 8 feet	Sandy limestone, high percentage of clay
8 - 11 feet	Sandy-clayey limerock

Casing set at 11 feet.

BORING #7

1 mile north of S-8

0 - 3 feet	Sandy clay, limestone cobbles
3 - 5 feet	Muck
5 - 6 feet	Soft light grey sandy clay, clayey sand
6 - 9 feet	Dark grey brown sandy clay
9 - 11 feet	Medium hard limerock

Continued BORING #7

11 - 14 feet	No return - very easy drilling, probably sand
14 - 19	Same as above until 17', at 17' large boulder encounter, deflecting hole sharply to one side and forcing the abandonment of the hole

BORING #8

1 mile north of S-8, 5 feet south of Boring #7.

0 - 19 feet	Same as Boring #7
19 - 24 feet	Very easy drilling, loose silt and fine to medium sand flowing out of hole until 22', at 22' mud flowed back into hole
24 - 27 feet	Medium hard drilling, no return
27 - 29 feet	Easy drilling, no return

BORING #9

1 mile east of S-8 on L-5 apron approximately 10 feet north of water's edge.

0 - 2 feet	Fill? light grey sandy clayey lime
2 - 5 feet	Muck
5 - 7 feet	Hard Limestone
7 - 10 feet	Loose silt and fine to medium sand
10 - 14 feet	Very soft drilling, no return, probably sand
14 - 19 feet	Same as above

Continued BORING #9

19 - 22 feet	No change in drilling but mud flows back into hole
22 - 23 feet	Very hard layer
23 - 29 feet	Very soft drilling-no return

BORING #10

2 miles east of S-8 on L-5 Levee

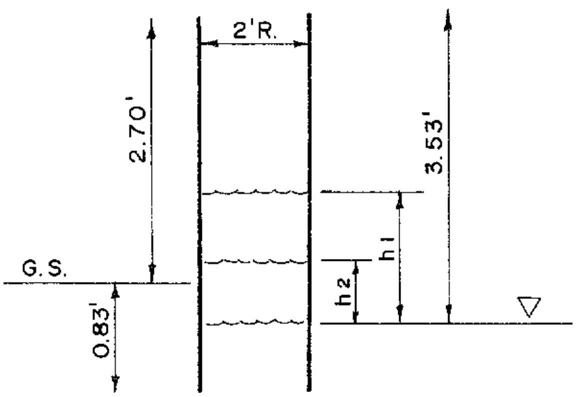
0 - 4 feet	Conglomeratic mixture of limestone sand, silt, and clay relatively low permeability, hard drilling
4 - 9 feet	Same as above, last 3 inches of drill rod covered with muck

PERMEABILITY TESTS FOR HOLEY LAND

SEEPAGE INVESTIGATION

1. Test Location: 200 feet northeast of S-8 pumping station on north side of Levee #5.

   Test Set-up: 8 inch I.D. PVC pipe, fully cased hole, casing flush with bottom in muck layer.



Test #1 Parameters

$h_1 = 1.26$ feet

$h_2 = 1.16$ feet

$\Delta t = 10$ minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \frac{h_1}{h_2} = 1.89 \times 10^{-2} \ \frac{\text{feet}}{\text{min.}}$$

Test #2 Parameters

$h_1 = 1.82$ feet

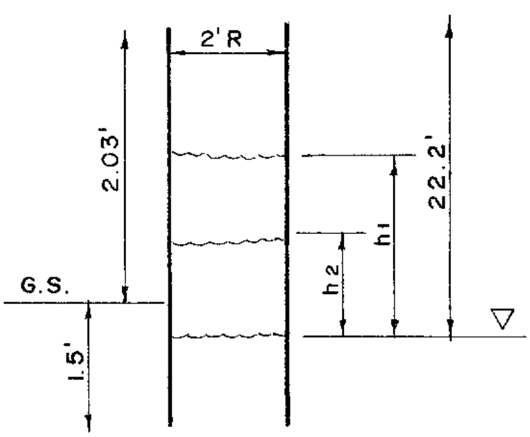
$h_2 = 1.33$ feet

$\Delta t = 15$ minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \frac{h_1}{h_2} = 4.78 \times 10^{-2} \ \frac{\text{feet}}{\text{min.}}$$

2. Test location: 200 feet northeast of S-8 pumping station, 3 feet east of location #1.

   Test Set-up: 8 inch I.D. PVC pipe set 1.5 feet deep in muck. Casing set flush with bottom of hole.



Test #3 Parameters

$h_1 = 1.07$ feet

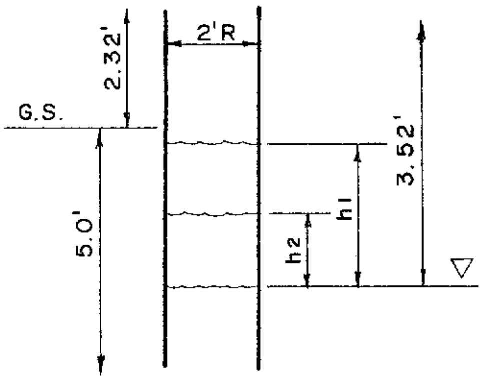
$h_2 = 0.56$ feet

$\Delta t = 64$ minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \frac{h_1}{h_2} = 4.78 \times 10^{-2} \ \frac{\text{feet}}{\text{min.}}$$

3. Test location: Six miles north of S-8 pumping station on east berm of Miami Canal.

Test Set-up: One and one-half inch I.D. PVC pipe set 5 feet at base of compacted muck. Casing is flush with bottom of hole.



Test #4 Parameters

h_1 = 0.44 feet

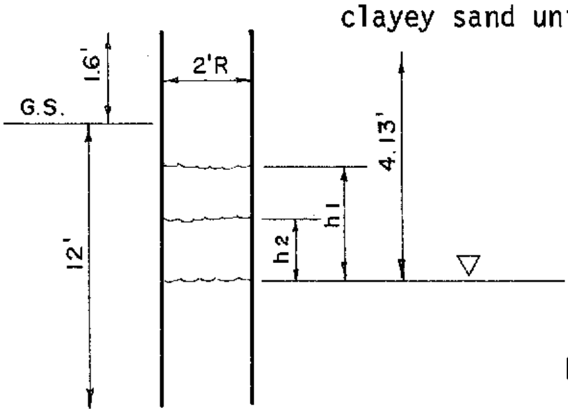
h_2 = 0.38 feet

Δt = 79 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ln \frac{h_1}{h_2} = 7.95 \times 10^{-4} \frac{\text{feet}}{\text{min.}}$$

4. Test location: Six miles north of S-8 pumping station on east berm of Miami Canal 10 feet north of location #3.

Test Set-up: One and one-half inch I.D. PVC pipe set 12 feet deep in clayey sand unit. Casing flush with bottom of hole.



Test #5 Parameters

h_1 = 3.86 feet

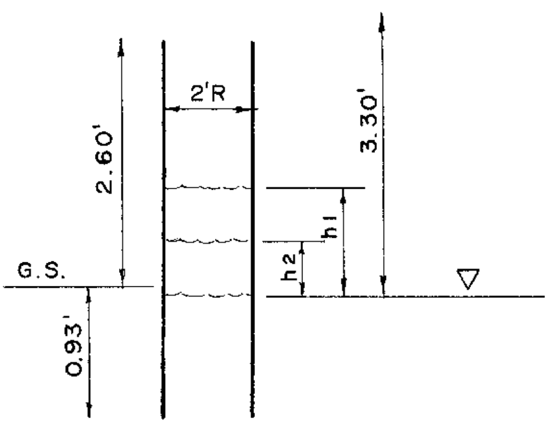
h_2 = 3.80 feet

Δt = 46 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ln \frac{h_1}{h_2} = 1.22 \times 10^{-5} \frac{\text{feet}}{\text{min.}}$$

5. Test location: Six miles north of S-8 pumping station on the retention area side of the Miami Canal east levee.

Test Set-up: Eight inch I.D. PVC pipe one foot deep in muck unit.



Test #6 Parameters

h_1 = 0.77 feet

h_2 = 0.38 feet

Δt = 46 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ln \frac{h_1}{h_2} = 3.5 \times 10^{-2} \frac{\text{feet}}{\text{min.}}$$

Test #7 Parameters

h_1 = 0.49 feet

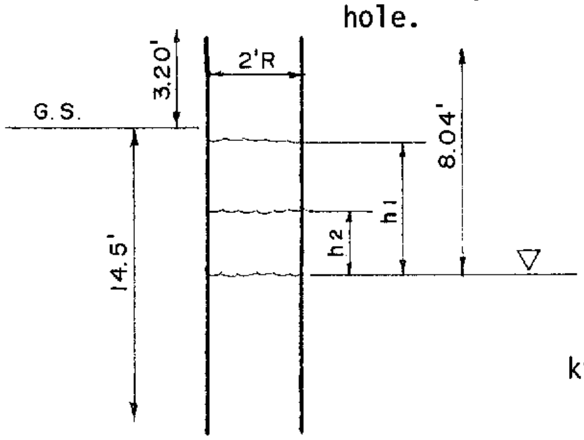
h_2 = 0.12 feet

Δt = 75 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \left[\frac{h_1}{h_2}\right] = 4.29 \times 10^{-2}\ \frac{\text{feet}}{\text{min.}}$$

6. Test location: Six miles north of S-8 pumping station on east berm of Miami Canal 10 feet north of location #3.

Test Set-up: One and one-half inch I.D. PVC pipe set 14.5 feet deep in hetrogenous unit. Casing set flush with bottom of hole.



Test #8 Parameters

h_1 = 6.70 feet

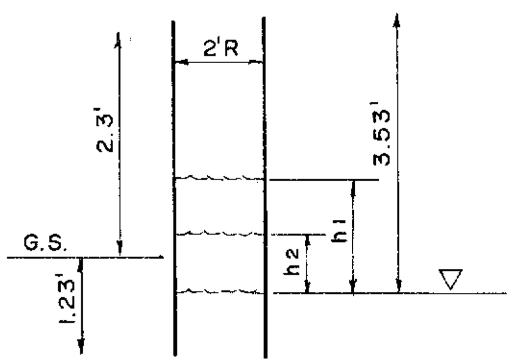
h_2 = 5.86 feet

Δt = 111 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \left[\frac{h_1}{h_2}\right] = 4.29 \times 10^{-2}\ \frac{\text{feet}}{\text{min.}}$$

7. Test location: One mile north of S-8 pumping station on east side of Miami Canal east levee.

Test Set-up: Eight inch I.D. PVC pipe set 1.2 feet deep in muck. Casing set flush with bottom of hole.



Test #9 Parameters

h_1 = 1.28 feet

h_2 = 0.38 feet

Δt = 59 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \left[\frac{h_1}{h_2}\right] = 4.7 \times 10^{-2}\ \frac{\text{feet}}{\text{min.}}$$

Test #10 Parameters

h_1 = 1.28 feet

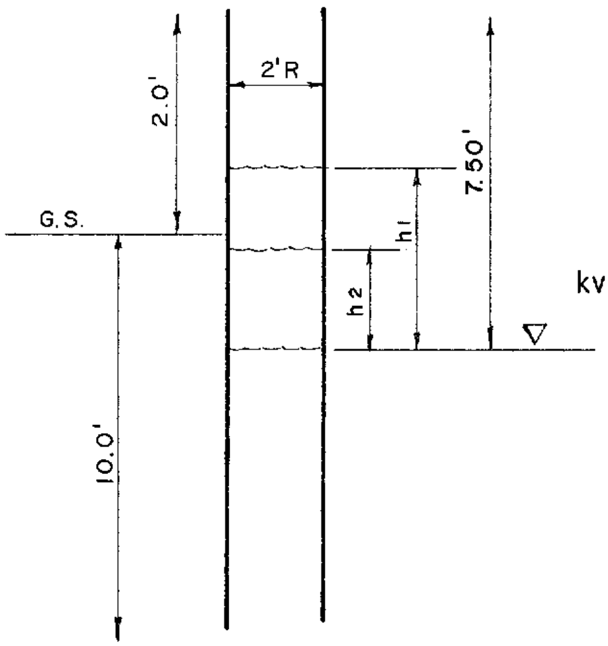
h_2 = 0.46 feet

Δt = 60 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \left[\frac{h_1}{h_2}\right] = 3.90 \times 10^{-2} \ \frac{\text{feet}}{\text{min.}}$$

8. Test location: One mile north of S-8 pumping station on east berm of Miami Canal.

Test Set-up: One and one-half inch I.D. PVC pipe set 10 feet deep at base of limestone unit. Casing set flush with bottom of hole.



Test #11 Parameters

h_1 = 7.5 feet

h_2 = 5.3 feet

Δt = 15 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \left[\frac{h_1}{h_2}\right] = 9.92 \times 10^{-3} \ \frac{\text{feet}}{\text{min.}}$$

Test #12 Parameters

h_1 = 5.53 feet

h_2 = 0.99 feet

Δt = 103 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ \ln \left[\frac{h_1}{h_2}\right] = 7.15 \times 10^{-3} \ \frac{\text{feet}}{\text{min.}}$$

9. Test location: One mile east of S-8 on north berm of L-5 borrow canal.

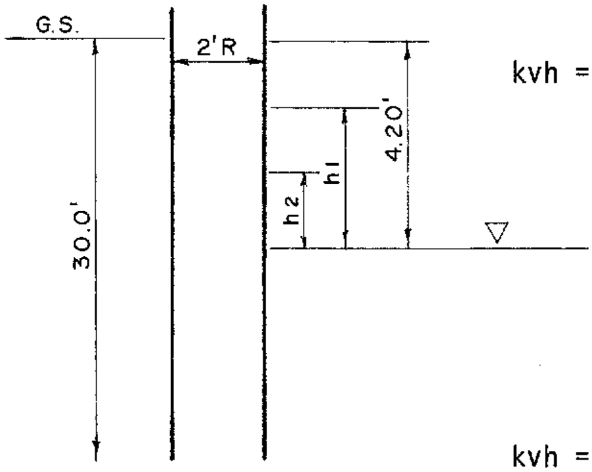
Test Set-up: One and one-half inch I.D. PVC pipe set 30 feet deep in fine grained unit. Casing set flush with bottom of hole.

Test #13 Parameters

h_1 = 1.34 feet

h_2 = 1.16 feet

Δt = 120 minutes



Test #13 (con't)

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ln \frac{h_1}{h_2} = 4.29 \times 10^{-5} \frac{\text{feet}}{\text{min.}}$$

Test #14 Parameters

h_1 = 1.50 feet

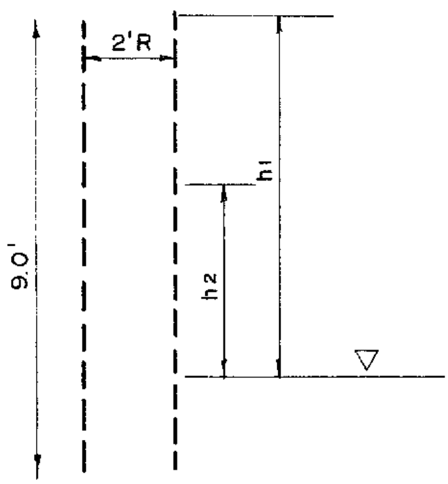
h_2 = 0.16 feet

Δt = 1320 minutes

$$kvh = \frac{2\pi R}{11\ (\Delta t)} \ln \frac{h_1}{h_2} = 6.05 \times 10^{-5} \frac{\text{feet}}{\text{min.}}$$

10. Test location: Two miles east of S-8 on Levee #5, north side of borrow canal.

Test Set-up: Nine foot deep uncased hole 4 inches in diameter. Base of hole is on top of compacted muck underlying the levee and fill material. Static water level is at 8 foot depth.



Test #15 Parameters

h_1 = 8 feet

h_2 = 5.03 feet

Δt = 10 minutes

R = 2 inches

D = 9 feet

S = 1.5 (Dimensionless)

$$K = \frac{R}{16\ DS} \frac{(H_2 - H_1)}{\Delta t} = 2.29 \times 10^{-4} \frac{\text{feet}}{\text{min.}}$$

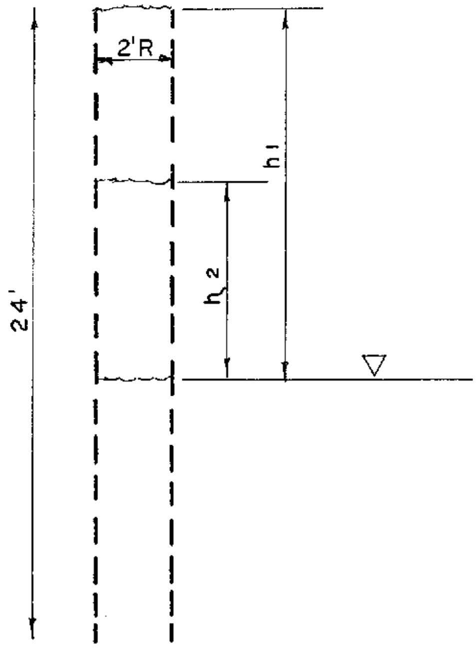
11. Test location: 200 feet northeast of S-8 pumping station at intersection of L-5 Borrow Canal and Miami Canal.

Test Set-up: Uncased four inch diameter hole 24 feet deep. Static depth of water at 4.20 feet.

Test #16 Parameters

h_1 = 4.20 feet

h_2 = 0.0



Test #16 (con't)

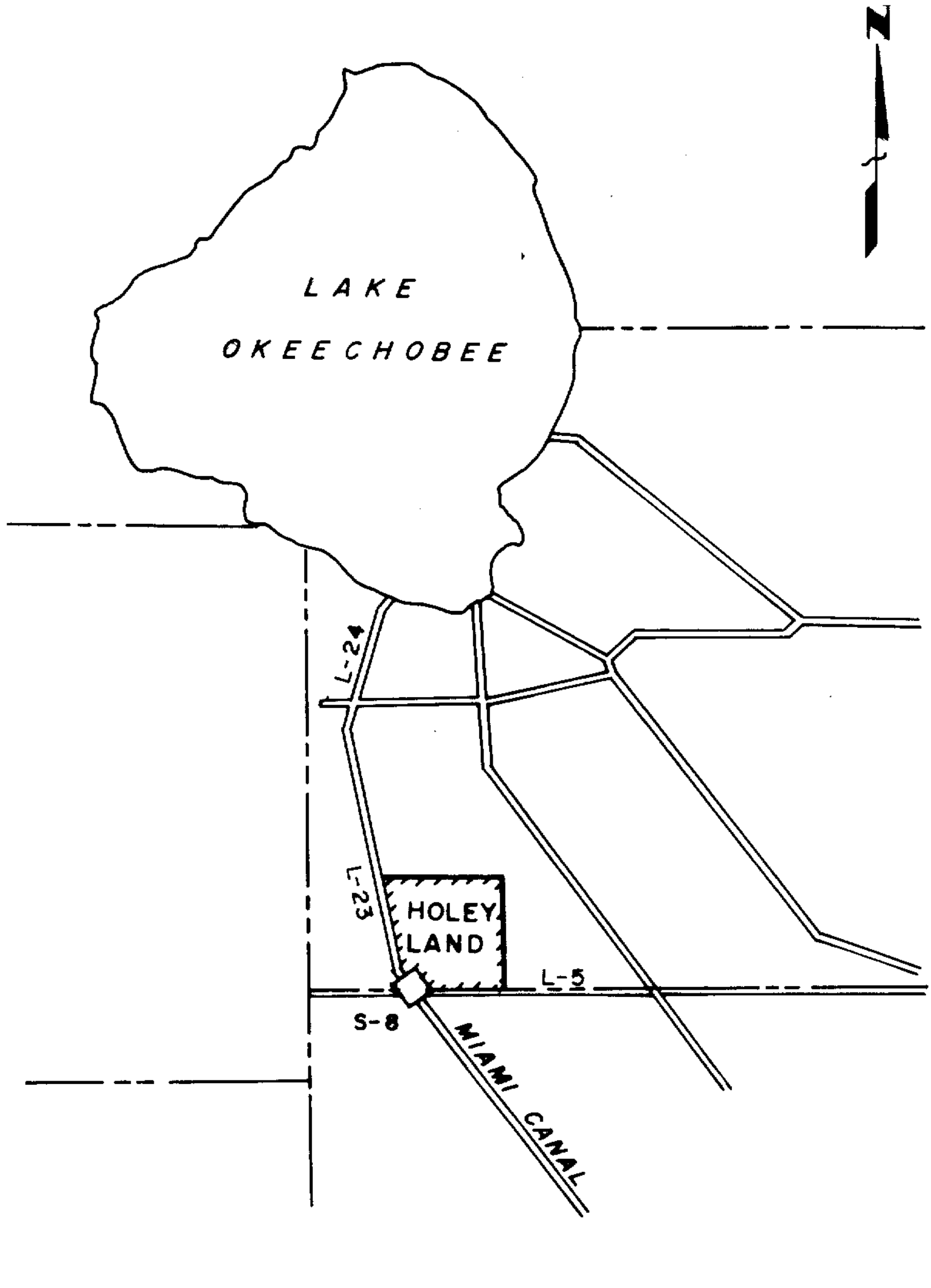
Δt = 8 minutes

R = 2 inches

D = 24 feet

S = 1.5

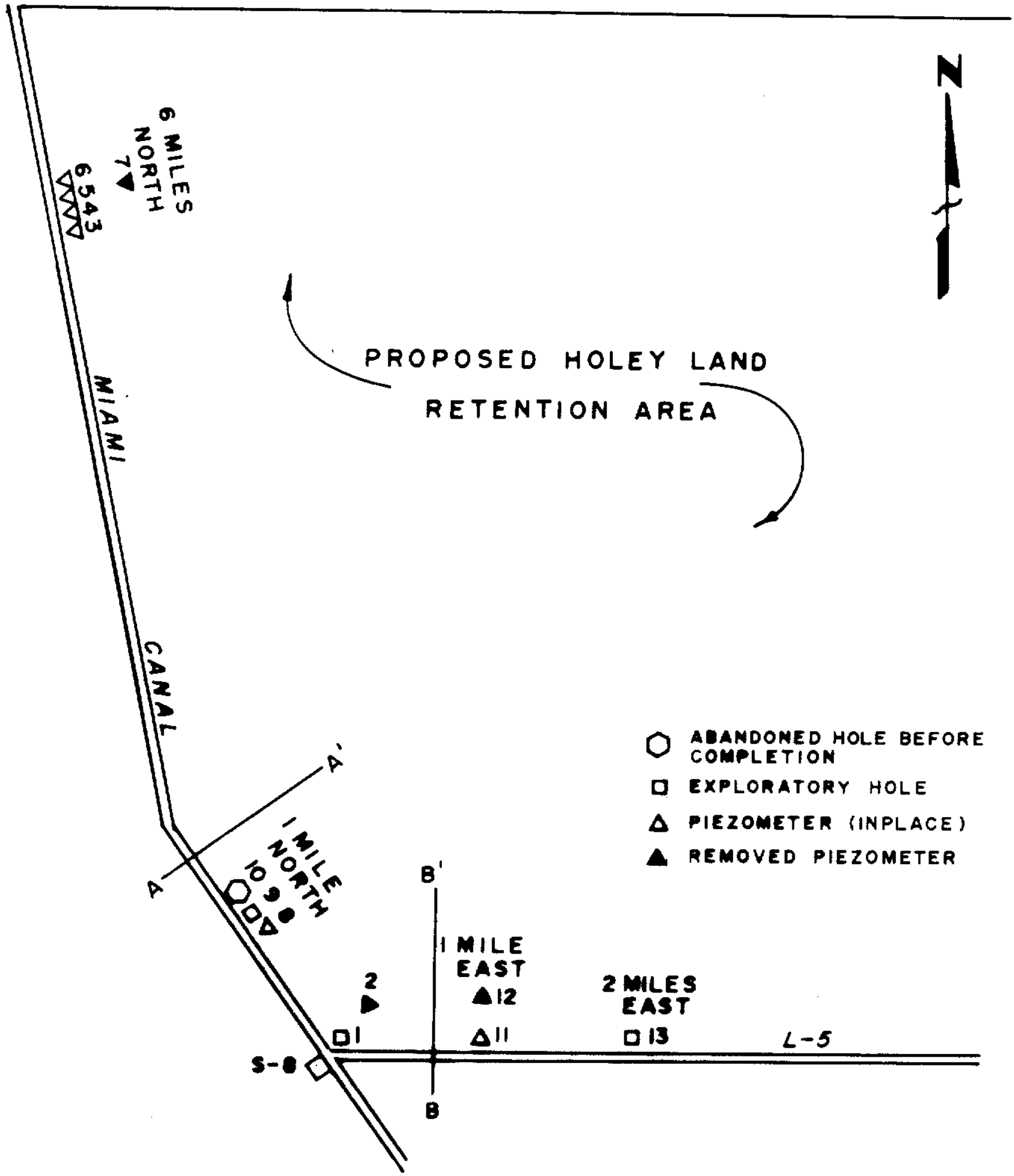
$$K = \frac{R}{16\,DS} \frac{(H_2 - H_1)}{\Delta t} = 1.52 \times 10^{-4} \frac{\text{feet}}{\text{min.}}$$



PROPOSED HOLEY LAND RETENTION AREA

SCALE 1" = 10 Miles

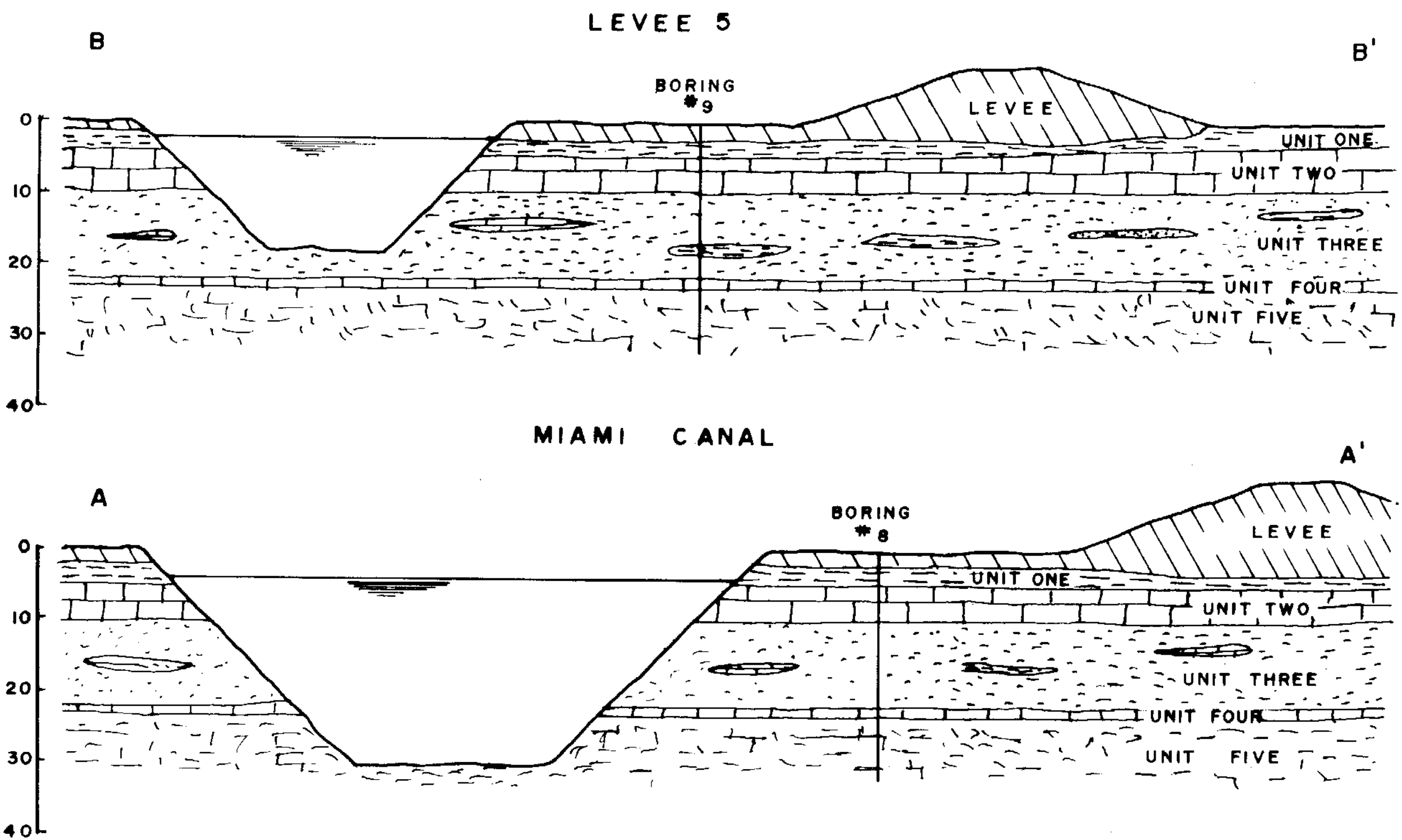
FIGURE 1



LOCATION OF EXPLORATORY BORINGS AND PIEZOMETERS RELATIVE TO S-8 PUMPING STATION

SCALE 1"=1 Mile

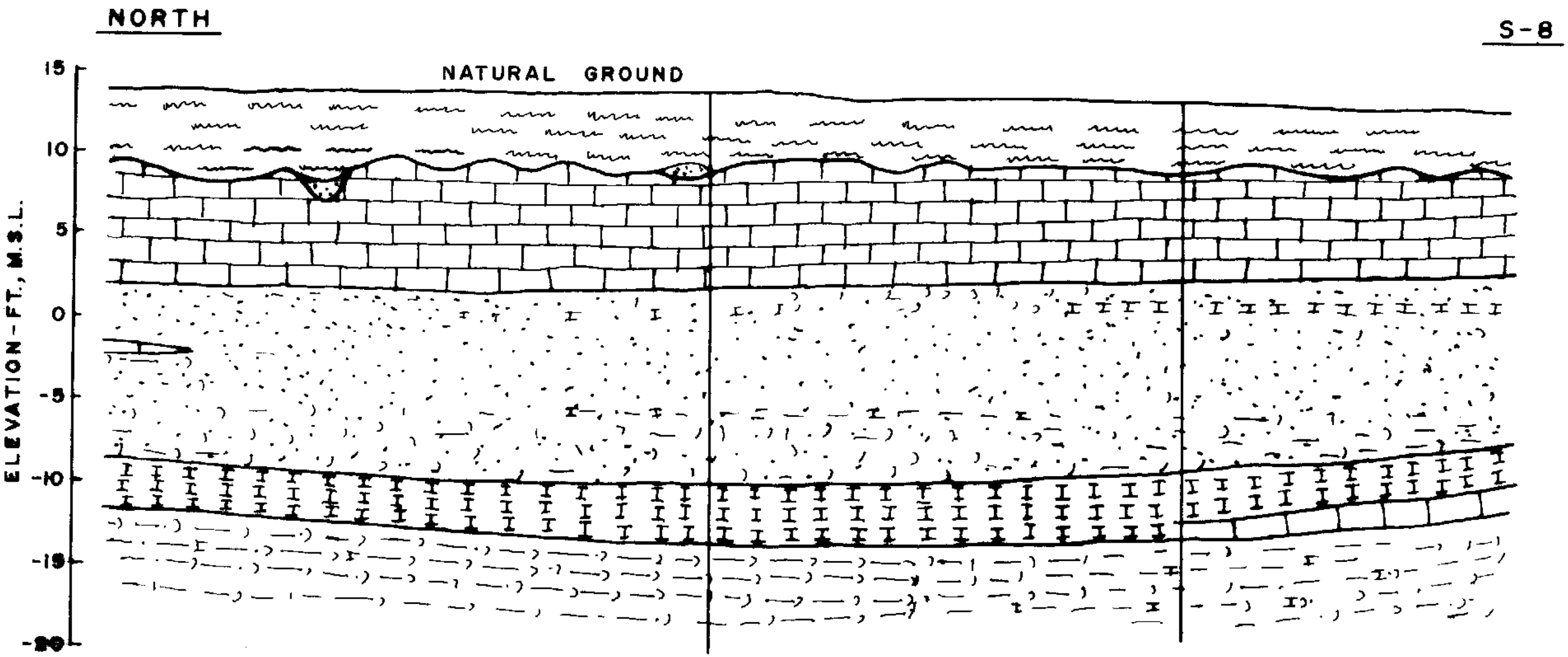
FIGURE 2



TYPICAL CROSS SECTIONS THROUGH MIAMI CANAL
AND LEVEE 5 BORROW CANAL

SCALE 1" = 20'

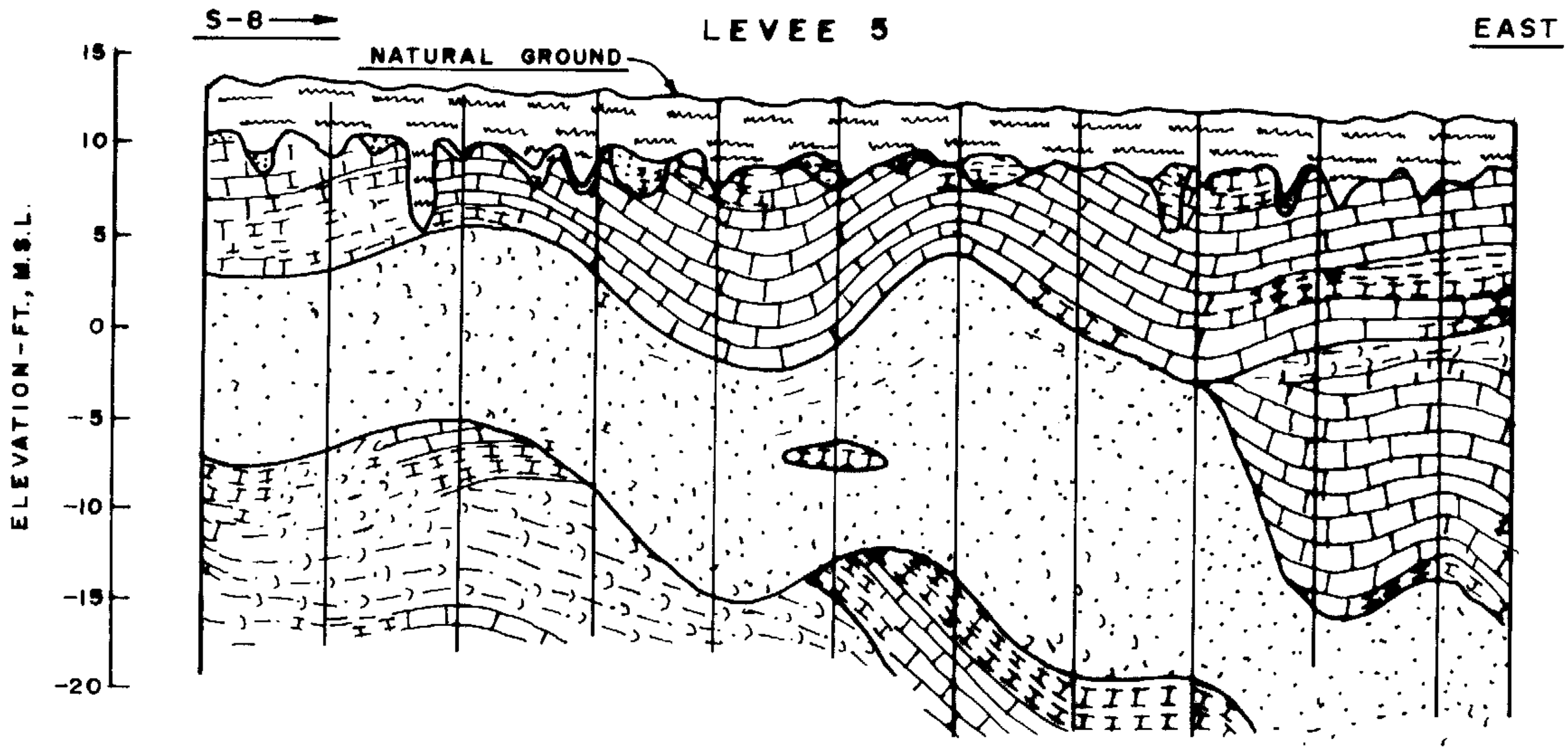
FIGURE 3



CORPS OF ENGINEERS BORING LOG FOR L-23 LEVEE FROM S-8 NORTH

SCALE 1"=2,000'

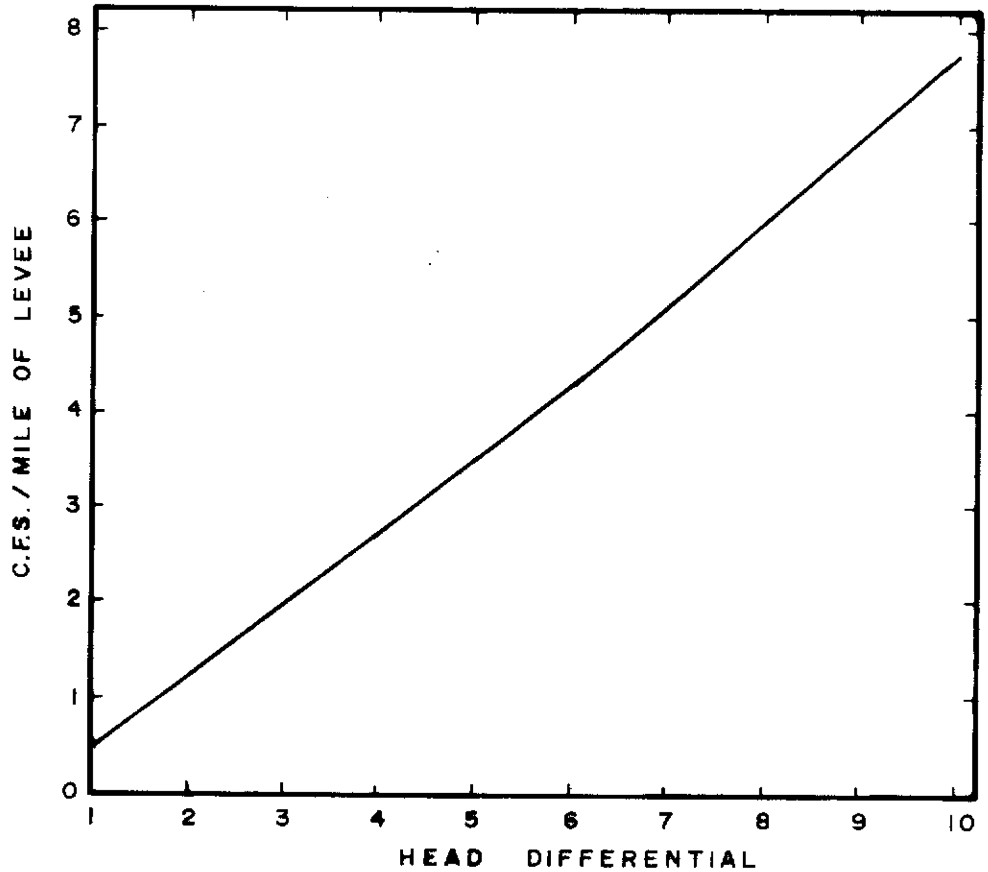
FIGURE 4



CORPS OF ENGINEERS BORING LOG FOR L-5 LEVEE FROM S-8 EAST

SCALE 1"= 4,000'

FIGURE 5



NONLINEAR RELATIONSHIP BETWEEN HEAD DIFFERENTIAL AND SEEPAGE

FIGURE 6